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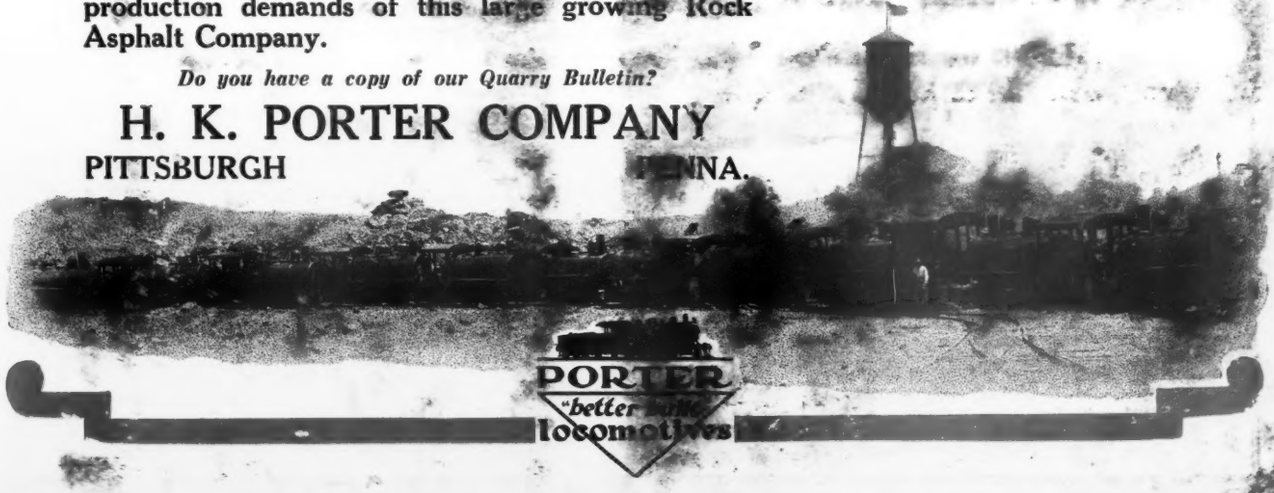

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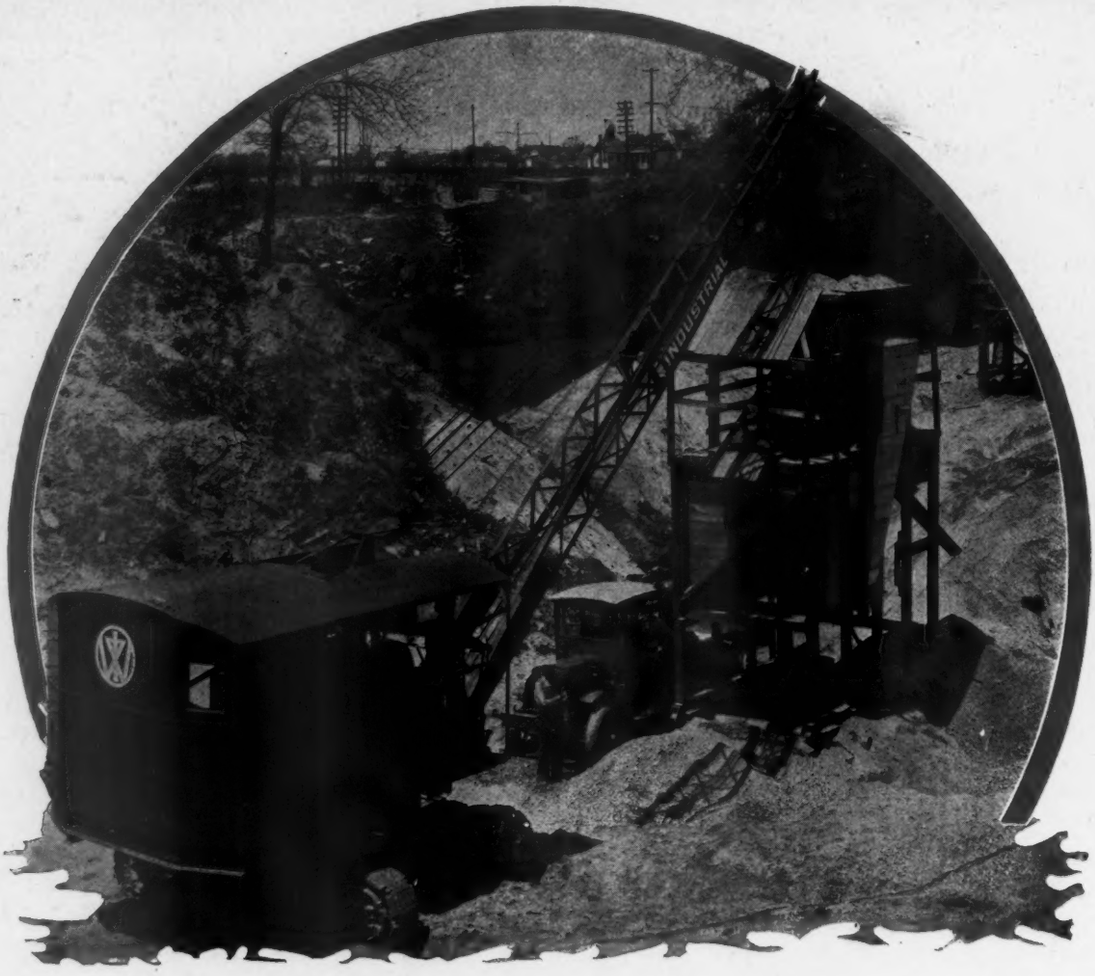

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Pit and Quarry

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Pit and Quarry

Vol. 13 CHICAGO, ILL., MARCH 2, 1927 No. 11

THE BACKBONE OF HOUSE ORGANS

JUDGING from the interest created and the comments made in connection with the article which appears in the January 19th number of Pit and Quarry entitled "House Organ Pays Stewart Sand Company" it appears that many readers consider the house organ a new idea. Some of the readers are considering for the first time using a house organ in their business. To these readers and others interested we should like to say that reader interest is the backbone of a successful house organ and unless an active reader interest is created the venture will not pay.

The "house organ" is not a new idea. "Poor Richard's Almanac" was a house organ for the print shop of Benjamin Franklin. System, Business, The Dodge Idea, Printer's Ink, Collier's, Harpers, Scribners, and others now recognized as "national magazines" were all, originally, house organs. The annual cost of all the industrial and mercantile house organs now being issued has been estimated at $11,000,000.

There is only one excuse for the existence of any house organ and that is; to sell the advertiser's product, be it merchandise or service. It may even be said that in this regard there is no difference between the industrial house organ and the Saturday Evening Post. The house organ is the medium for the sales promotion of the products or service of one house. The national magazine or newspaper is a medium for the sales promotion of the products or services of a group of houses. One is a house organ. The other is a houses organ. Therefore, if you issue a periodical to your trade, your employees, or to any group, you are as much a publisher in fact as George Horace Lorimer, Frank Munsey, or any other publisher.

As there is only one reason for the existence of any magazine, so there is only one thing that will give a house organ the ability to sell. That single thing is reader interest. Without reader interest it will fail in its purpose regardless of volume of circulation. The periodical that reaches a subscriber, regardless of what he has paid for it—much or nothing—only to remain unopened, is doing no one any good.

How then can reader interest best be developed? It being admitted that fundamentally there is little difference between a house organ and a national magazine the answer to this question can be found in the analysis of any good journal. On the cover of the successful magazine will be found an attractive picture—something that in itself creates interest and a desire to look further. Or, there may appear the titles of three or four of the leading articles. This also tends to create the desire to read—reader interest. Upon turning the cover, there will be found an advertising section. Following this will appear cracking good articles and stories written by intelligent, thoughtful, capable writers. Each article, furthermore, is liberally provided with illustrations, hand letterings, "run-arounds" and numerous little what-not publisher's tricks that make the material inviting to the eye and easily read.

A comparison of the average house organ with such a national magazine would make it necessary to imagine a widely circulated periodical filled with such articles as: "How Husslefoot Shoes Are Made" —"Why the Bounce Coupe is Best"—"What Happened to Mrs. Jones' Dough When She Used Dina-Mite Baking Powder," etc. Would not the prestige of a national magazine suffer a severe slump if material of this sort appeared regularly? Yet is not that the sort that fills many house organs? "But," you say, "why should I publish something in which I am not interested? Our paper has got to advertise us, hasn't it? And after all—it is our periodical."

Decidedly not. You may publish and pay for a house organ but it is not yours. It belongs to your readers. They either buy it or you give it to them —so it naturally belongs to them. And to be a successful publisher you must give the reader what he wants. You may be a vegeterian and hate the smell of meat, but to be a successful restaurateur you must serve your patrons steak and bacon. As for advertising you and your business—if you write an article about snow-flakes and do it in such a fashion that the majority of the readers will thank you for having written it, they will remember where they read the story and you will profit accordingly.

Briefly, here is an editorial policy for any house organ: Build a magazine for your readers. Learn from them what they want—then publish it. Keep the reading pages wide open for the honest expression of intelligent opinion on any side of any question effecting your business.

"HAND-TO-MOUTH" BUYING BENEFICIAL

CURRENT buying habits, usually styled as "hand-to-mouth," have benefited manufacturer and consumer alike. Under the new basis factories are as busy as ever, dealers are busier, and the consumer's interests are served with more satisfaction than in past years when it seemed necessary to warehouse surplus merchandise for which there was no immediate demand. In the beginning of the present era, economists viewed the tendency with disgust and looked forward to the time when business would return to its "normal state." The "return" never materialized, and because of the development of rapid transportation together with the fact that under the new order factories may run with fewer peaks and valleys in the production curve, it probably never will.

As distribution is nearly always accompanied by advertising, the advertiser is directly effected by the changed conditions in a way that rebounds to his advantage. Whereas buyers bought only once in a long period they now find themselves in the market continuously. Advertising can therefore maintain interest as it never could before. And because the market is kept constantly open, due to small purchases, continuity in advertising is of tremendously increased importance. Publicity now has a chance to talk in terms of news, to deal with new forms of service, and new ways in which the buyer's convenience has been studied and supplied. Because of this advertisers who formerly used space in business and trade mediums merely to keep the name before the prospect, now obtain quicker and more tangible results since customers who buy in small quantities and frequently need retain the advertising message for only short periods. When the salesman arrives on the scene it is more likely today than ever before that the printed message of his house is still fresh in the buyer's mind.

The new order of things is a boon to new products and those who would ordinarily hesitate to try them. When material was supplied in quantities sufficient to fill long interval requirements, investments were higher and this naturally generated hesitancy on the part of the buyer to make a change. The buyer need now never turn down new designs or new equipment which promises marked improvement over the old. He can buy a single specimen or a small quantity only, make restricted tests, and if the new material does not give the increased satisfaction hoped for the investment made is comparatively small. It is true of course that "hand-to-mouth" buying necessitates more frequent calls on the part of the salesman. This is off-set, however, by the more ready market. Taken by and large the new order of things is wholly beneficial to industry.

GOOD HOUSEKEEPING

WHILE in the army we were drilled, in no uncertain fashion, on the merits of good housekeeping. The weekly inspection of the Colonel was a dreaded event, for a single missing button, or the tiniest spot of grease was sure to fall within the range of his observation—with a result that was not soon forgot. Slovenliness has no place in military life, for slovenliness in physical make-up engenders slovenliness in mental structure, and the latter, in war, sometimes leads to a little wooden cross, marked with a "dog-tag," leaning a bit to the leaward since the previous night's rain.

All of which was called to memory by a recent visit to a large industrial plant in Ohio. While on a hasty tour of this plant we noted, with some amusement, a large 14-foot sign over the door of the shipping department which read: "This is the dirtiest department in the plant." In answer to our query, the superintendent silently lead us to the assembling department where, perched over the en-entrance was a similar sign reading: "This is the cleanest department in the plant." He then went on to explain that on Saturdays at twelve, the factory superintendent in company with an official from the general offices, made a tour of the entire establishment for the sole purpose of inspecting the place for neatness and good housekeeping. To the department that showed up as being the cleanest and more orderly went the "clean" sign, while that department which proved inexcuseably dirty or disorderly had the imposition of the "dirtiest department" sign for an entire week. According to the superintendent, the men of the institution found considerable pleasure in hunting out the "dirtiest department" on Monday mornings, then "riding" the men for their slovenliness throughout the remainder of the week. The idea, according to the superintendent, "works wonderfully well."

Good housekeeping is as imperative to industrial life as to military life. Disorderliness contributes to accident hazard, costly production and low morale, while neatness and cleanliness invariably tend to reduce accident totals, effect important economies in production and increase over-all efficiency. It is no easy task to keep a large plant spick and span, year in and year out. Particularly is this true where bulk materials are handled or where there is an abundance of maintenance work. Logical rules, rigidly enforced, with suitable penalties for infraction thereof or appropriate reward for adherance thereto, will do much to keep any plant in orderliness. The returns from such effort are always sufficiently high to justify the work.

FOUR MILLION TONS OF SAND AND GRAVEL PRODUCED ANNUALLY BY THIS COMPANY

By F. A. Westbrook

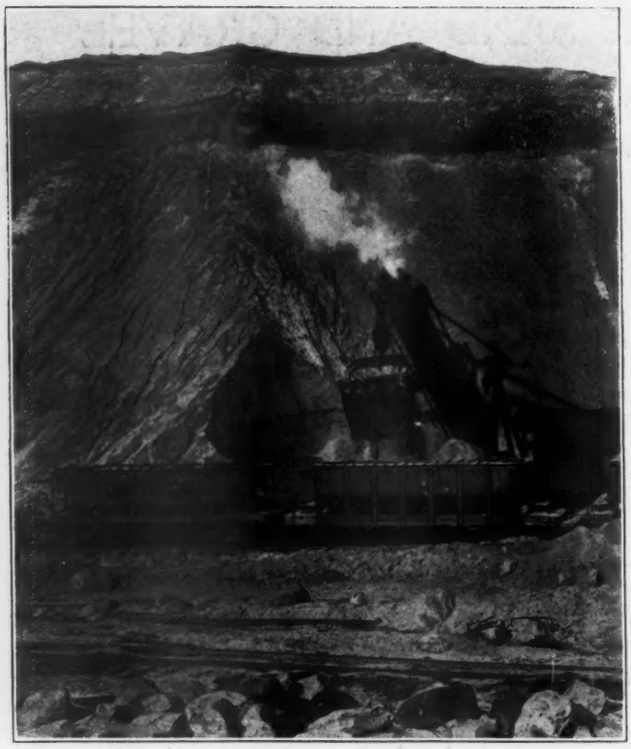
THERE is nothing more fascinating to write or read about than something which has superlative characteristics. The imagination reacts to it instantly. This is one reason why the Goodwin-Gallagher Sand and Gravel Corporation at Port Washington, Long Island, is of unusual interest as it has the largest sand and gravel operations in the world. Its production is approximately 4,000,000 tons per year, it owns 117 one thousand ton barges, 8 tugboats powerful enough to pull from 25 to 35 barges, and employs 350 men at its plant with 150 on its floating equipment.

Needless to say the plant has been developed to a high degree of efficiency and uses the most modern labor saving machinery. Like all large operations, which have grown rapidly, some parts of it are better than others. Some of the very extensive equipment is almost always in the process of being overhauled and improved so as to prevent the development of unsatisfactory conditions. Therefore, in reading the following description, this fact should be borne in mind.

A very determined effort is being made at the plant toward standardization as, originally, the plants varied considerably as to the size and make of the various equipment. This condition is being rapidly eliminated, although there are many problems to be solved calling for a variation from standard practice, owing to the large quantities of material handled. Now the Company only calls for bids on equipment after the specifications have been drawn up by their own employees and thoroughly checked as to their suitability for the work involved. Trial installations of new devices are almost continuously under way and if the apparatus can be made to show an improvement, with modifications if necessary, it is adopted. In some instances the peculiar needs of the Company call for something foreign to the operation. For instance, the Company recently built a new tug boat which moves scows in and out of the slips where they are loaded. It was built in the Company's own shipyard according to prepared designs. The tug has a peculiar appearance because the pilot house has been made disproportionately high to its other dimensions; but this is a practical thing to do because it would not otherwise be possible for the captain to see over the barges when they are empty and therefore high out of the water. To have a pilot house of conventional height would mean possible ramming of the slips with much resultant damage to both vessels and docks.

The property covers over 850 acres and has a shore frontage of over 4000 feet on Hempstead Harbor. Along this frontage is the Company's own shipyard, which is now in process of reconstruction. In it will be constructed tug boats and barges. Here also are located the docks, or slips, in which the barges are loaded directly from overhead track by the efficient method of having the bottom-dump gondola cars discharge directly into the barges. All shipments are made by water and

View of tracks leading out to the barge loading slips



Loading cars by steam shovel in the sand pit

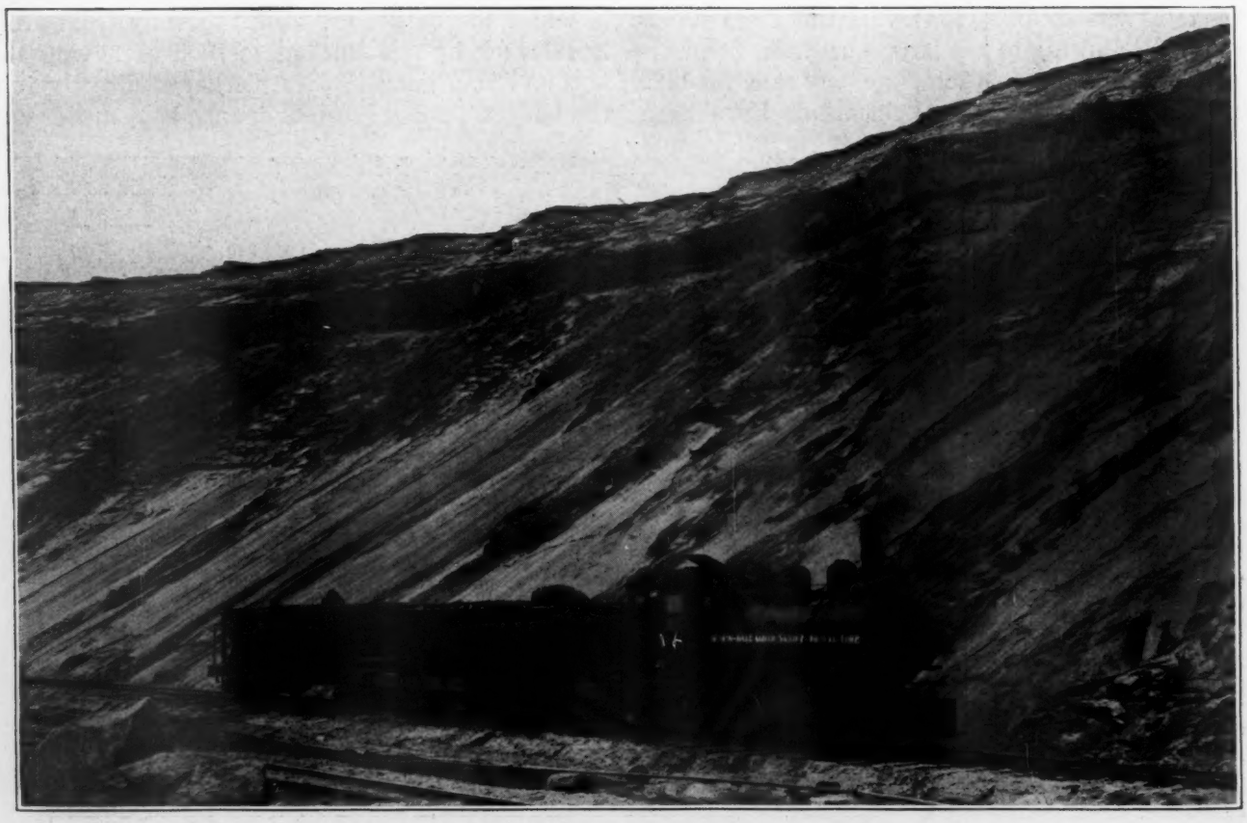
are all delivered in New York State or Northern New Jersey.

Material is taken from the pits by steam shovels. At present there are in service 9 Marion shovels of the following types; four No. 92, one No. 70, one No. 60, one No. 50 and two No. 20, as well as a No. 70 Bucyrus shovel. These shovels load directly into gondola type cars, of 30 ton capacity, of the Company's own specification and made by the Magor Car Company. Porter locomotives are used, in the majority of cases, to haul the trains, made up of 3 cars, to and from the pits. Material from the storage bins is taken to the barges in similar cars hauled by locomotives.

There is an interesting detail about the locomotives which should be mentioned, namely, the use of Monel metal shields over the tops of the boilers in order to prevent rusting. This is necessitated by the fact that the washing is done with salt water, and as the locomotives are continually passing under the bins, used for loading the cars, the locomotives are subject to the dripping water and would soon corrode to a serious extent if not thus protected.

There are two screening and washing plants, one of which is known as the Phoenix, or South plant, and the other as the North, or Gallagher plant. Both of these plants take in raw materials at two points. The Phoenix plant is now being reconstructed and will therefore be described only partially. The new trestle is being constructed so that trains of cars may be run to a large hopper, which is conveniently situated for this purpose but some distance away from the screens.

The material from the pit is dumped directly into the hopper from the bottom of the gondola cars and passes over an iron bar grizzly. The large stones slip off into a Farrel jaw crusher and the



Hauling a load of sand for dry screening out of the pit

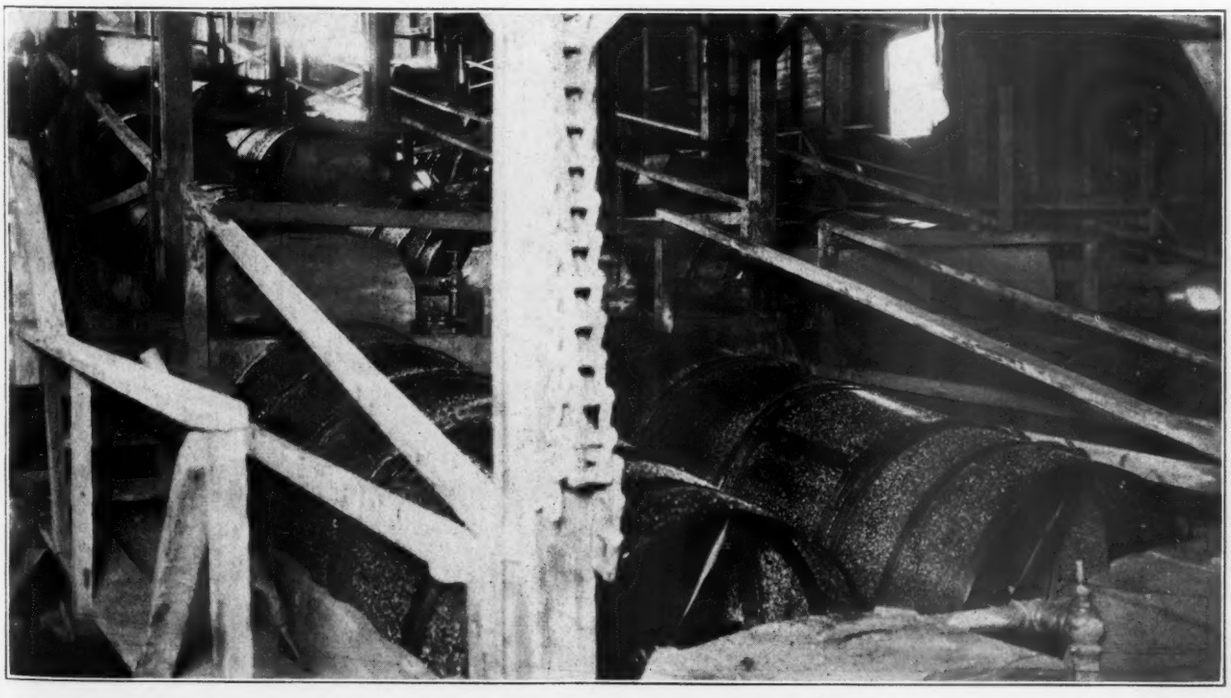
bulk of the material into bins. It is carried to the plant by means of two 36 inch belt conveyors on 400 ft. centers. This equipment is new and uses Robins idlers with Timken roller bearings. The drive, which is a double tandem, is to be by means of a 75 h.p. Westinghouse motor for each conveyor, using reducing gears and couplings. One of the belts is being furnished by the New York Rubber Belting Company and the other by the Gutta Percha Company. From the crusher there will be cross conveyors discharging on to the main conveyors.

These new conveyors will feed into the top of the screening and washing house. This consists of twenty-four cylindrical rotary screens, 48 inches in diameter and 12 feet long, divided into four series of six each. The sand and water finally go to settling tanks and the commercial sand is drawn off into bins. The other sizes of material are also deposited in their respective bins.

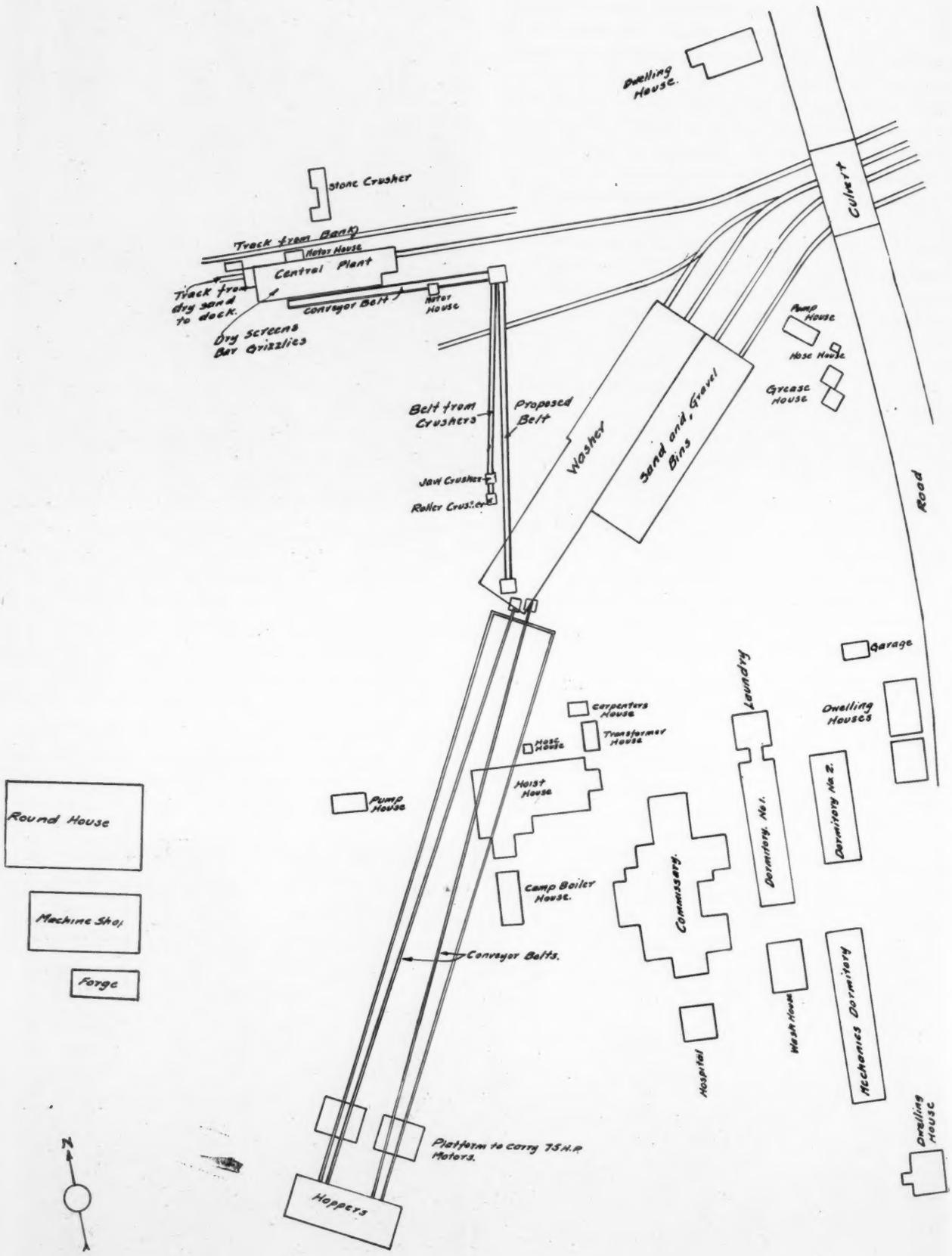
Dry sand is produced at the other end of this plant. It is brought in train loads, and dumped over bar grizzlies with a 3 inch opening. The material which passes through the grizzlies is then taken up in three parallel bucket elevators and passed over dry screens, the sand going directly into bins. The rejects from the grizzlies drop to a bin, at the foot of the central plant, from which it is fed by gravity into a Farrel jaw crusher. From here the crushed stone is raised by a conveyor to the screens.

As there is, at times, a surplus of the larger sizes at this plant two crushers have been installed, near the washed gravel bins, which may be fed through chutes with such of these larger sizes as it is desirable to reduce. One of these machines is a Farrel jaw crusher and the other is a Buchanan 16 x 42 roll crusher. The crushed stone from these crushers is taken by means of a belt conveyor back and discharged into a bin, hoisted and then rescreened. The arrangement of tracks serving the grizzlies and storage bins is shown in one of the illustrations. It is interesting to note that all the newer conveyor idlers are of the roller bearing type furnished by the Robins Conveying Belt Company and all electrical equipment by the Westinghouse Electric Manufacturing Company.

Loading cars in sand pit



Interior view of screen house



Layout of the Phoenix Plant of the Goodwin Gallagher Sand and Gravel Corporation

North or Gallagher Plant

The North or Gallagher plant has recently been completely rearranged and brought up to the best standards of modern practice and is worth a careful description. The first thing to be noted is that the material is brought in at two points from two different working levels of the pit. The material from the upper bank, or level, is washed and that from the lower bank is screened as it comes from the pit without washing.

We will first consider the screened, but unwashed sand. It is delivered to the plant in trains made up of gondola cars. These are dumped over a central grizzly which removes the large stones. These slip off into an Acme 10½ D crusher and then on to a 24 inch belt conveyor. This crushed stone conveyor discharges into the gravel conveyor, coming from other parts of the operation.

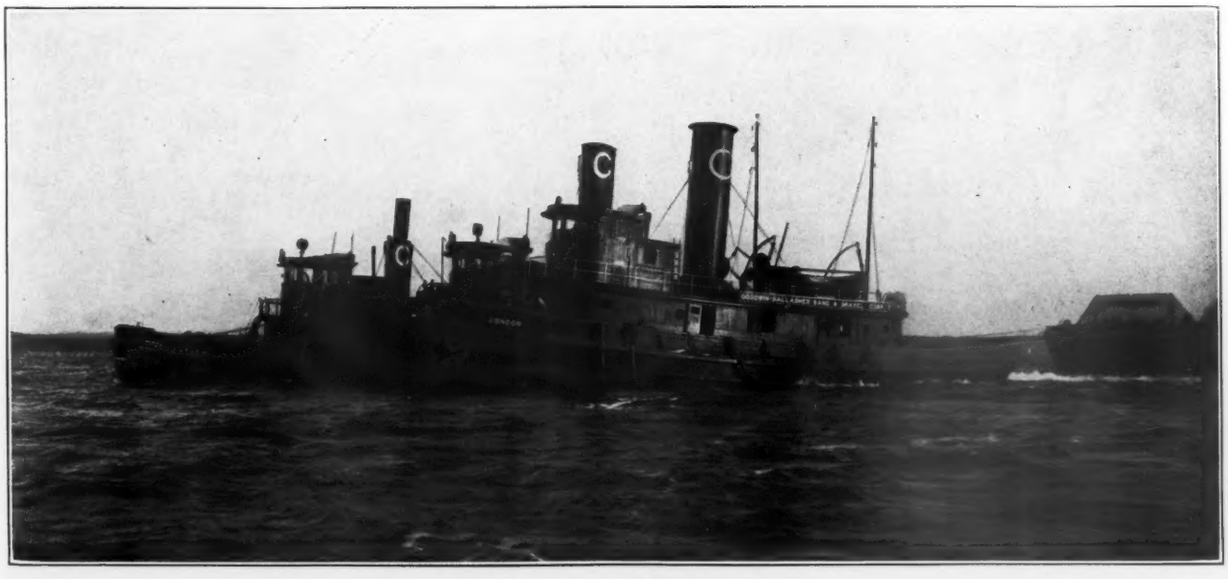
The material which passes through the central grizzly, as described above, is sand and gravel and is carried by five 36 inch conveyors, varying from 330 feet to 340 feet between centers, to a series of central stationary screens situated over large sand bins. These screens are placed at an angle of about 45 degrees and are made of wire. Gravel which is separated from the sand at these screens slips on down the incline to a 30 inch belt conveyor, 306 feet between centers, which discharge into the gravel conveyor, from the upper bank hoppers to the washing plant. The railroad track passes under the dry sand bins so that cars may be backed under them, loaded and taken out to the docks for shipment.

There is also another conveyor associated with the dry sand bins. This consists of two 24 inch belts on 236 foot and 271 foot centers, respectively, which carry dry sand to the mixer. Another series of two 24 inch conveyors, 79 foot and 250 ft. between centers, have been installed to carry the gravel to the mixer. From here there is a 30 inch

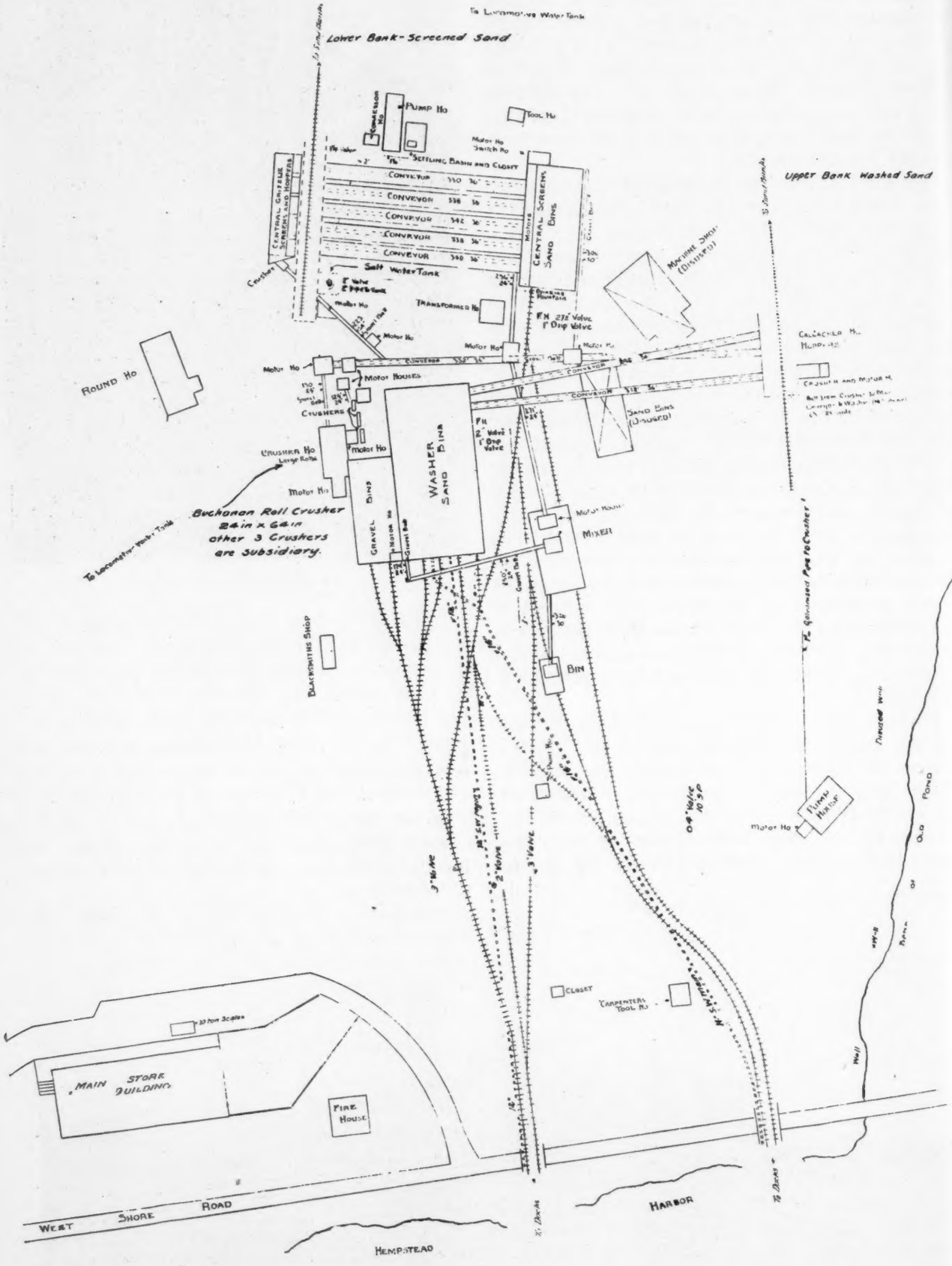
View of conveyor to screens

conveyor, 326 feet between centers, to a large overflow storage bin for mixed material. Lastly it will be seen that a railroad track passes under the mixing bins loading this material on cars so that it may be taken out to the docks for shipment.

Now we will follow the material brought from the upper bank of the pit and which is washed. It is dumped into hoppers over bar grizzlies which shunt the large stone into a Buchanan jaw crusher. These hoppers discharge on to two 36 inch belt conveyors, 294 foot and 312 foot between centers,



Tow on Long Island Sound



Layout of the Gallagher Plant of the Goodwin Gallagher Sand and Gravel Corporation

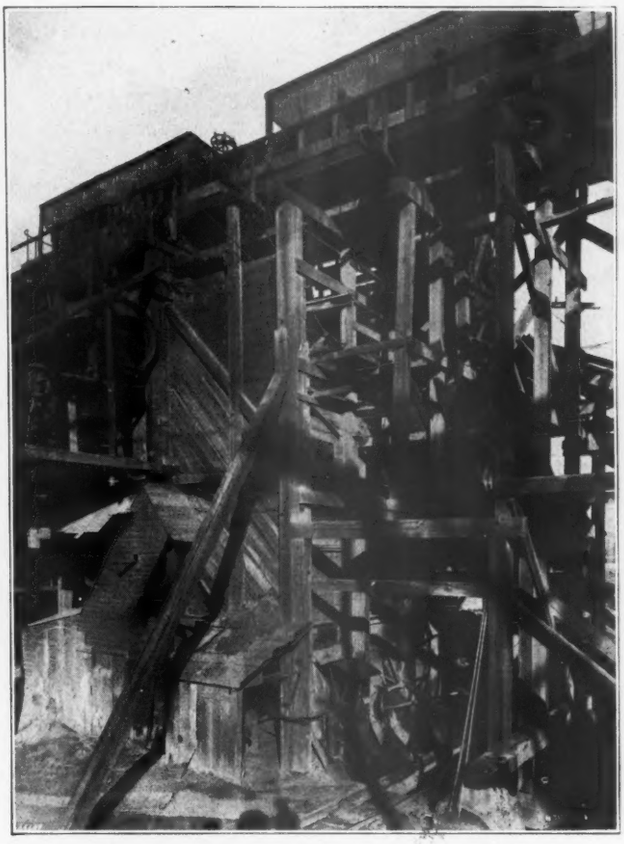
which carry the mixture of sand and gravel to the top of the washer house.

At the hoppers there is a third 36 inch belt, 332 foot between centers, which extends from them to a Buchanan roll crusher located near the washed gravel bins. This belt is fed from several sources. First from the jaw crusher, adjacent to the dry sand grizzlies; second by the rejects from the dry sand stationary screens; third by a 24 inch belt conveyor, 63 foot between centers, from the crusher at the Gallagher Hill hoppers, and fourth from one of the latter hoppers where the accumulations of large size gravel are dumped which, however, are small enough to pass through the grizzlies. This third conveyor carries the material to a series of three jaw crushers. A 24 inch x 64 inch Buchanan roll crusher is served by a 24 inch belt conveyor on 130 foot centers. As a general thing the roll crusher is the only machine used and the other three are merely held as reserves. The crushed stone is then taken to the top of the washer house by a 30 inch conveyor.

We have now followed the material until it is concentrated at the top of the washer house. It is here mixed with a stream of water and divided in two directions, into four lines of five revolving screens each. These are made of tank steel and are 48 inches in diameter and 12 feet long. Additional streams of water come in at each screen. The various sizes of gravel are deposited in their respective bins and the sand laden water is run into settling tanks, which were made on the premises. From the tanks the sand is discharged into bins ready for loading into freight cars. It is apparent that mechanical handling has been highly developed. This is made still more striking when we consider that 20,000 tons a day, of 9 hours, is handled at this plant with the help of only 300 men.

The amount of water used is, of course, very considerable. Salt water from the harbor is used for washing and is supplied by four 8 inch Jeansville pumps and three 10 inch Worthington pumps with a capacity of half a million gallons per nine hour day. The fresh water is obtained from a series of artesian wells using an 8 inch Dean Triplex vertical pump. The drip lines are collected in a sump at each plant and together with the dirty water from the washers is lifted by two 8 inch Morris sand pumps with an 8 inch American Well Works pump for reserve.

Numerous other interesting particulars about this large operation are worth mentioning. There is a concrete main store and office building, which has been made by the Company's men in their spare time, that is when there were slack periods from time to time in the regular work of production. Such periods frequently occur on account of adverse tides, during which shipments are held up. This building was carefully designed to fit the needs of their particular requirements and by careful arrangement of storage bins, etc. the business of stock keeping has been greatly simplified.



Unloading sand at plant to be conveyed to washer

At the present time there are two forge shops and two machine shops divided between the two plants. These are about to be consolidated so as to concentrate all repair and maintenance operations, of a similar character, at one point, which is undoubtedly in the interest of efficiency. Among the various articles of equipment which are in use in these shops are three lathes, one shaper, one planer, three drillpresses, one boring mill, one shear, one punch, steam hammer, hydraulic press, turret lathe, oxy-acetylene and electric welding machines, various air compressors, sand blasting machine, spraying outfit for painting cars and scows.

The Company has three trucks, two Mack and one Reo. The Mack trucks are used for transporting coal and other materials about the plant, and occasionally to and from Port Washington. The Reo is used to bring in the lighter materials from New York where the Company has a central receiving station. The very heavy materials are brought in on barges and lifted by the Company's derrick lighter Dorothy.

The matter of electrical service has been handled in a rather unusual but very practical way. Instead of having one outdoor transformer station where the voltage is stepped down for utilization and from which current is distributed throughout

Aeroplane view showing plant, docks and sand pits. Barges are loaded in slips, under the tracks, from which cars dump material

the plant, there are several such points. At each of these the transformers are placed in Blaw-Knox steel-frame, metal sheathed houses. The disconnecting switches, oil switches, high and low tention buses have been installed in a neat and workmanlike manner. Disconnecting switches for the low tension feeders, which serve the various motors, or groups of motors, are mounted on racks.

The Company has also a mill for drying sand for use in making plaster, with a capacity of 500 tons daily. This is located about one-half mile north of the Gallagher plant with the new shipyard between the two plants. This drying sand mill will be described in a subsequent issue of PIT and QUARRY. For the men, without families, there are dormitories for the common laborers and houses for the mechanics. All are equipped with electric light, steam heat and hot and cold running water. The commissary feeds two hundred men at each meal. For this purpose there is a large dining hall and a smaller room for the mechanics. Recreational facilities in the form of pool tables and card playing are provided for. There is also a hospital building.

The situation of the plant is rather isolated with the result that the workers have to be brought in from a distance, and as there are no convenient housing facilities it is a matter of necessity for the company to take care of its men in this way.

Another social activity which has met with great success is the fire company. Everybody is not admitted to this. Only those workers are eligible who have proven their worth by the length and quality of their service. A very neat house for the fire fighting apparatus has been provided which has also a club room on the top floor. This is a social center for the old employees and apparently a great source of satisfaction to them. Fire drills are frequently held and as a matter of fact some very effective work has been done in fire fighting and prevention.

The general executive, sales, purchasing and despatching offices are at 21 East 40th St., New York City. Despatching tows require the services of two men who are kept busy maintaining a steady flow of material to consumers and seeing that empty barges are not delayed in being returned to the plant. The fact that this has to be synchronized with the continually changing tides makes the work all the more difficult to handle.

Source of Profits

"The profits of a business are not earned by the sales department on sales. Sales are merely opportunities to realize finally on all the planning and work that have gone before. As a matter of fact, the profits of a business are not earned by any single department, and some of them are not even earned; they are saved. Your purchasing department, for instance, doesn't earn profits but it may save them. So with your credit department and all your other non-productive departments. You see, profits are the sum total of an accumulation of many small advantages, earned or saved at every point in a business. Keep that before you always, for it is the key to profitable management." (Spoken by Burton Dexter, the banker, in "Captains in Conflict,"—the story of the struggle of a business generation, by R. R. Updegraff).

General Business Conditions

In a discussion of the general business conditions of the country which appeared in the January bulletin of the National City Bank, the editor has this to say:

"So much is said in current discussion to the effect that high wages are the secret of this country's prosperity that in the interest of clear understanding it is well that some qualifications be made. High wages which accompany high productivity, either as a cause or result, undoubtedly make for prosperity and the general welfare, but high wages which contribute to high industrial costs and are passed on for consumers to pay have no beneficial results. If they yield benefits to the recipients it is at the expense of the rest of the community, and if no more substantial basis than this existed for the country's prosperity the outlook would be poor.

"The real basis of prosperity is that as a rule prices to consumers have advanced less than wages, thus enabling the wage-earners to consume a larger physical quantity of goods. This could not be so unless productivity was increasing. If wages and prices both advance 50 per cent with production remaining the same, it is evident that the wage-earning class will have no greater command over commodities than before and that its consumption cannot increase. This is a fundamental truth which is ignored in much of current discussion. Wage increases without increased production signify nothing but the competition of industrial groups with each other. If one wins larger buying powers, it does so at the expense of the others.

"If, however, by the installation of improved machinery in production or more powerful locomotives in transportation, the costs of production or transportation are lowered and prices are reduced accordingly, the result to every consumer will be precisely the same as though his wages had been increased, for a portion of his buying power will be available for new purposes. The improvement in social conditions so much desired is not obtained by wage-battles, which usually are costly and wasteful, or by victories for wage-earners which result in higher prices to consumers, but as Mr. Green, President of the American Federation of Labor, describes by 'expanding productivity so that the cost of the manufactured article will be reduced instead of increased.'"

QUANTITIES, WEIGHTS AND HEAT CONTENTS OF FLUE GASES FROM ROTARY KILNS

By Karl Blume*

THE German cement industry was considerably injured by state control during the War and post War period and was strongly limited in its natural technical development and as a result until recently was unable to undertake "rationalization" of operations in the true and better sense of the word. That is to say, advantage has not been taken of the available technical equipment which would lead to an increase in production or a better utilization of the producing elements with a consequent decrease in overhead. This condition was particularly true as during all these difficult times the heavy costs involved in the complicated solution of such a problem was tied up with the problem of improving the quality of cement appreciably.

So it is no wonder that the German cement industry from the production point of view has not advanced to the extent which the means available would have permitted. It is characteristic of this condition that until recently no advances were made from the point of view of the utilization of heat in the German cement industry contrary to the condition in other German industries, in spite of the fact that ways and means were available for such a utilization. To name only one such method of increasing the efficiency of the rotary kiln from the point of view of heat utilization we need only mention the utilization of the sensible heat of flue gases of rotary kilns in waste heat boilers for the production of steam or power.

It is therefore all the more pleasing to record that recently waste heat boilers have been constructed and, as was to be expected, have proved successful in use. In view of the great importance of a correct determination of the basic figures for these waste heat boilers it seems fitting and desirable to enter into all the important factors relating to such waste heat boilers, that is to say, to gather all the important figures entering into consideration and to give an example of the calculation of the quantities, weights and heat content of such an installation.

The calculation of the above named values and properties is based on:

1. The determination of the content of calcium carbonate ($CaCO_3$) and of Magnesium carbonate ($MgCO_3$) of the raw material.
2. The ultimate analysis of the fuel used for combustion in the rotary kiln.
3. Flue gas analysis.
4. The measurement of the temperature of the flue gases.

From the values given under headings 1-3 we obtain the composition, the volumes and the weight of the flue gases which in combination with the temperatures determined under 4 and the specific heat at constant pressure enable the heat content to be estimated which determines the capacity of the boiler.

For a rotary kiln working by the slurry process (50 meters long and 3 meters in diameter) all the necessary values and the method of calculation are given in the following table:

Clinker production of the kiln 170 tons per 24 hours
Clinker production of the kiln.....7 tons per hour
Percentage of $CaCO_3$ in the slurry.....76%
Percentage of $MgCO_3$ in the slurry.....1.5%
Water content 40%
Content of water of crystallization.....2%
Ash content of the fuel.....6.9%
Fuel consumption in percentage of clinker production 30%
Molecular weight of $CaCO_3$.....100
Molecular weight of CO_2.....44
Molecular weight of $MgCO_3$.....84.32

If we call:

x = the weight of raw material necessary for the production of 1 kg of clinker
a = the water content of the raw material in kg
b = the content of dry substance of the raw material expressed as $CaCO_3$ in kg
C = the content of dry substance of the raw material expressed as $MgCO_3$ in kg
d = the content of water of hydration in kg
e = the ash content of the fuel in kg
f = the fuel consumption in kgs

we have as the requirement of raw material to produce 1 kg of clinker by the usual methods of calculation:

$$\times = 1 + \times a + \times \cdot d(1-a) + \times \cdot \left[1-a-0.02(1-a)\right] \left[0.44 \cdot b + \frac{44 \cdot}{84.32} \cdot c\right] - e \cdot f$$

or

$$\times = \frac{1-e \cdot f}{1-\left[a+d(1-a)+0.98(1-a)\left(0.44 \cdot b+\frac{44}{34.32} \cdot c\right)\right]}$$

In substituting the above values we obtain for the requirements of raw material in kg necessary for 1 kg of clinker in the limiting case where a fuel without any ash content is used, that is to say,

*(in Zement, Dec. 23, 1926, pages 931-934)

where e = o :

$$\times = \frac{1.552}{1 - a} \quad \text{(formula 1)}$$

For the water which is contained in the form of vapor in the flue gases we have

$$H_2O = \times \left[a + 0.02\,(1 - a) \right] \quad \text{(formula 2)}$$

For carbon dioxide

$$CO_2 = 1.55 \cdot 0.98 \quad (0.44 \cdot 0.77 + \frac{44}{84.32} \cdot 0.0\,15)$$

$$= 0.52 \text{ kg} \quad \text{(formula 3)}$$

In Fig. 1 we have for various percentages of water from 0-50% the weights necessary for each kg of clinker of $\times$, CO_2 and H_2O according to formulae 1-3. In using an ashless fuel we thus have: For a water content of:

	7% H_2O	40% H_2O
$\times$ =	1.668 kg	2.5875 kg
H_2O =	0.148 kg	1.0675 kg
CO_2	0.52 kg	0.52 kg

For any values of e and f, that is to say, for any fuel consumption per kg of klinker (f) with any ash content per kg of coal (e) we can obtain the desired values for

$\times$ kg of raw material
H_2O
CO_2

by multiplying the values obtained according to formulae 1, 2 and 3 by the factor $(1 - e \cdot f)$. Assuming f = 0.30 kg and e = 0.069 kg we have:

$\times$ =	2.5325 kg
H_2O =	1.0440 kg
CO_2 =	0.5092 kg

With an hourly production of 7 tons of clinker we produce each hour:

$CO_2 = 0.5092 \cdot 7000 = 3564.4$ kg
$H_2O = 1.044 \cdot 7000 = 7308$ kg

Recalculating this to the basis of 1 kg of fuel consumption we have liberated from the raw material for each kg of fuel =

$$CO_2 = \frac{3564.4}{2100} = 1.697 \text{ kg or } \frac{1.697}{1.977} = 0.858 \text{ cu. met.}$$

$$H_2O = \frac{x7308}{2100} = 3.48 \text{ kg or } \frac{3.48}{0.804} = 4.33 \text{ cu. met.}$$

CO_2, SO_2, H_2O, N_2,

in which we have 1.977 as the weight of a cubic meter of carbon dioxide and 0.804 the weight of a cubic meter of water vapor in kg at O°C. and 760 mm of mercury pressure.

In addition to this carbon dioxide and water vapor we have for complete combustion without excess of air the following products resulting from the burning of the coal.

CO_2, CO_2, H_2O, N_2,

and when we have complete combustion with excess of air which generally occurs in pulverized coal combustion we may have oxygen (O_2) also (see table 1).

In order to be able to determine the content of O_2 and N_2 from the percentage of oxygen as given by the flue gas analysis we must first calculate the volumes of gas produced by burning coal completely without excess of air. In the following considerations in order to avoid misunderstandings we shall call the gaseous products resulting from the combustion of the coal "combustion gas" (with water

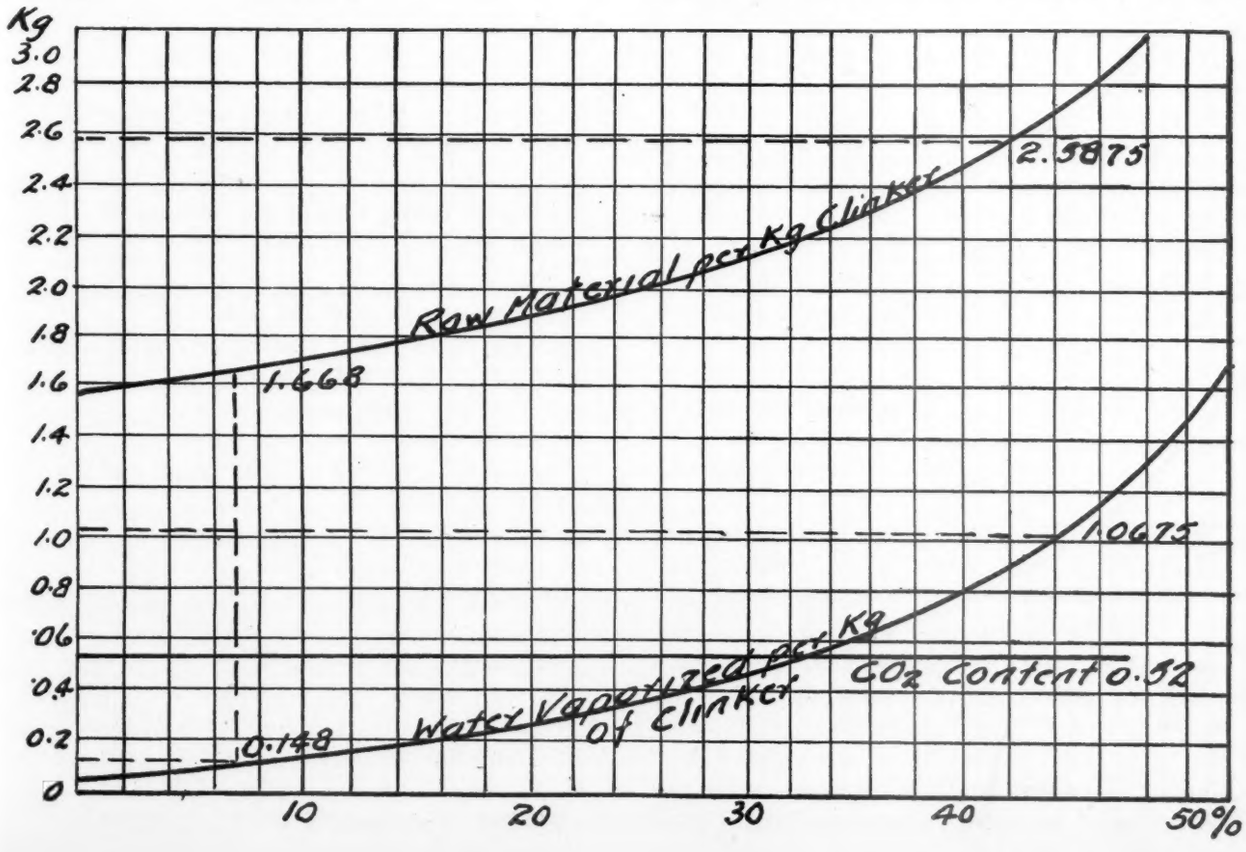


Table I

Air Required, Weight of Combustion—Gas and Volume, and Maximum CO_2 Content

Composition in Kg.	Oxygen Required in Kg.	Products of Combustion	Products of Combustion in Kg.	1m³ of gas weighs Kg.	The Products of Combustion Calc. to 0° and 760mm amount to m³ of Wet Gas	Dry m³	Gas %	Max. CO_2 content of dry gas
C=0.76	2.667·C=2.03	CO_2	3.76·C=2.79	1.977	1.865·C=1.419	1.419	18.6	$\frac{1.419}{7.60769}$ =
H_2=0.0494	8.00·H_2=0.395	H_2O	9.00·H_2=0.444	0.804	11.19·H_2=0.552			18.6% CO_2
O_2(+N_2)=0.0922	1.00·O_2=0.0922							
S=0.0124	1.00·S=0.0124	SO_2	2.00·S=0.0248	2.863	0.70·S=0.00869	0.00869	0.114	
H_2O=0.0170		H_2O	1.00·H_2O=0.0170	0.804	$\frac{0.0170}{0.804}$ =0.0212			
Ash=0.0690		N_2	$\frac{76.8}{23.2}$ .O_2=7.7600	1.254	2.635·O_2=6.1800	6.1800	81.286	
1.0000	Oxygen=2.3452 Requirement Air=$\frac{2.3452}{0.232}$= 10.14 Kg.		11.0362		8.18089	7.60769	100.000	

vapor or dry). We shall call the gaseous product resulting from the addition to the above of the carbon dioxide released from the dry substance of the raw material as well as the water vapor liberated from the raw material by the drying process, "flue gas."

The calculation of the air required for the combustion gas etc. is most easily carried out by the method used by Herberg in his "Hand Book of Combustion Technology" according to table 1 as this method of calculation shows all the values required and at the same time permits an exact visualization of the importance of the individual factors and the process of calculation, which is generally not the case when complete formulae are used. As a result of the production during the drying and deacidification treatment of the raw material of the above mentioned quantities of

0.858 cubic meters of CO_2
4.33 cubic meters of H_2O

the quantitative composition of the flue gases on complete combustion without excess of air will be altered as follows:

CO_2 = 1.419 + 0.858 = 2.277		17%
H_2O = 0.5732 + 4.33 = 4.9032		36.7%
SO_2	= 0.00869	0.065%
N_2	= 6.18	46.235%
cubic meters	13.36889	100%

The dry flue gases consequently contain

CO_2 = 2.277 cubic meters	26.95%
H_2O =	—
SO_2 = 0.00869	0.1%
N_2 = 6.18	72.95%
8.46569 cubic meters	100%

As even in the case of so nearly ideal a combustion as occurs with pulverized coal complete combustion without any excess of air is unobtainable in practice we must add to the above calculated values an amount of oxygen and nitrogen corresponding to the excess of air used; this excess is calculated from the flue gas analysis. It is therefore advisable to determine the oxygen content of the flue gas as the determination of the oxygen content by itself gives us a broad picture of the course of the combustion in the kiln even if it is not absolutely exact without taking into account the composition of the coal or of the raw material such as would be necessary in investigating the flue gas for its CO_2 content.

From the consideration that when an excess of air is used the volume of nitrogen added is 3.77 times as great as the excess of oxygen it follows that dry flue gas, if $\times$ represents the volume of oxygen sought as representing the excess of air, must have the following composition:

CO_2 = 2.277 cubic meters
SO_2 = 0.00869 cubic meters
N_2 = 6.18 + 3.77 $\times$ cubic meters
O_2 = $\times$ cubic meters

the total volume of the flue gases based on each kg of fuel burned is therefore in cubic meters 8.46569 + 4.77$\times$. In addition, for instance, if the flue gas analysis shows an oxygen content of 3% the following equation must hold:

$$0.03 = \frac{\times}{8.46569 + 4.77 \times}$$

From this we find that the oxygen volume in excess for each kg of fuel burned is:

$\times$ = 0.2962 cubic meters

The nitrogen volume is

6.18 + 3.77 · 0.2962 = 7.298 cubic meters

the excess air ratio is

$$\frac{7.298}{6.18} = 1.18$$

The dry flue gases therefore have the following composition.

CO_2 = 2.77 cubic meters	23.112%
SO_2 = 0.00869 cubic meters	0.088%
N_2 = 7.298 cubic meters	73.8%
0_2 = 0.2962 cubic meters	3%
9.87989 cubic meters	100%

The weight of the combustion gases resulting from the multiplication of the air necessary for combustion by the factor 1.18 is given as follows including the water vapor:

$CO_2 = 1.419$	m^3	1.977 kg/m^3	2.8	kg
$H_2O = 0.5732$	m^3	0.804 kg/m^3	0.46	kg
$SO_2 = 0.00869$	m^3	2.927 kg/m^3	0.0254	kg
$N_2 = 7.298$	m^3	1.231 kg/m^3	9.14	kg
$O_2 = 0.2962$	m^3	1.429 kg/m^3	0.424	kg
			12.8494	kg

The combustion of a kg of coal with the excess of air assumed above thus results in the production of approximately 13 kg of combustion gas. We might take up the possibility of calculating the weight of flue gases per hour. It is

1. Weight of combustion gases	$12.8494 \cdot 2100 =$	26983.74 kg
2. Weight of water vaporized	$1.044 \cdot 7000 =$	7308.00 kg
3. Weight of carbon dioxide CO_2 liberated	$0.5092 \cdot 7000 =$	3564.40 kg
		37856.14 kg

In order to know the heat content of the flue gases before entering the boiler equipment and after leaving the boiler we must determine the gravimetric composition of the flue gases including water vapor. It turns out to be

$CO_2 = 2.277$	m^3	1.977 kg/m^3	4.5	kg
$H_2O = 4.9032$	m^3	0.804 kg/m^3	3.94	kg
$SO_2 = 0.00869$	m^3	2.927 kg/m^3	0.0254	kg
$N_2 = 7.298$	m^3	1.251 kg/m^3	9.14	kg
$O_2 = 0.2962$	m^3	1.429 kg/m^3	0.424	kg
14.78309	m^3		18.0294	kg

The total weight of the flue gases produced per hour is thus:

$18.0294 \cdot 2100 = 37856.14$ kg

The weight of the flue gases per cubic meter is 1.22 kg and a kg of flue gas at 0°C. and 760 mm of mercury pressure thus has a volume of 0.82 cubic meters. The above values determine the dimensions of the cross sections of flue pipes, boiler and chimney.

The heat content of these 37856.14 kg of flue gases is obtained by multiplying the weights of the individual cases by their average specific heat at constant pressure per kg of gas at the specified temperatures of 400°C. before entering the boiler system and 150°C. at their exit from the boiler system. These values are taken from "Heat Technology of Gas Generators and Steam Boiler Operation" by Paul Fuchs, 3rd ed. page 30.

The average specific heat is accordingly:

at 400°C. $\frac{5.298}{18.0294} = 0.294$ (C_p at 400°C.)

at 150°C. $\frac{5.071}{18.0294} = 0.281$ (C_p at 150°C.)

(C_p is the specific heat at constant pressure for the temperature or temperature interval indicated while kcal is the heat unit representing the raising in temperature of 1 kg. of water 1°C.). The heat content of the hourly production of flue gases is consequently:

$36856.14\ 0.294 \cdot 400 - 0.281 \cdot 50) = 2850000$ kcal

At an efficiency for the boiler of 85% and a heat requirement per kg of steam of 700 kcal (13 atmospheres pressure and 300°C. superheat) we have a steam production of

$\frac{2850000 \cdot 0.85}{700} = 3460$ kg per hour,

or with a consumption of 5 kg of steam per H.P. hour we have a production of

692 H.P. hours or
510 KW

Heat Balance

If the coal used has a heating value of 7300 kcal per kg the total heat used in the production of a kg of clinkers is $\frac{7300 \cdot 30}{100} = 2190$ kcal. This quantity of heat in a kiln with a waste heat recovery boiler is distributed as follows:

1. Latent heat of formation of the clinker		487 kcal	22.25%
2. Recovery of energy in the steam		346 kcal	15.8%
3. Loss from the flue:			
a) sensible heat of the flue gases $18.0294 \cdot 0.3 \cdot 150 \cdot 0.81$ / 0.81	228 kcal		
b) heat of vaporization of the water vapor $1.044 \cdot 538.8$	563 kcal		
	791 kcal	791 kcal	36.14%
4. Loss by conduction and radiation			
a) of the kiln	505 kcal		
b) of the boiler	61 kcal		
	566 kcal	566 kcal	25.81%
		2190 kcal	100%

The heat balance of a kiln without a waste heat recovery boiler is represented herewith:

$CO_2 = 4.5$	kg $C_p = O.$	2213 at 400°C.	0.995 kcal	$C_p = O.$	2066 at 150°C.	0.93	kcal
$H_2O = 3.94$	kg $C_p = O.$	4867 at 400°C.	1.92 kcal	$C_p = O.$	4568 at 150°C.	1.8	kcal
$SO_2 = 0.0254$	kg $C_p = O.$	2213 at 400°C.		kcal $C_p = O.$	2066 at 150°C.		
$N_2 = 9.14$	kg $C_p = O.$	2514 at 400°C.	2.29 kcal	$C_p = O.$	2461 at 150°C.	2.25	kcal
$O_2 = 0.424$	kg $C_p = O.$	22 at 400°C.	0.093 kcal	$C_p = O.$	2153 at 150°C.	0.091	kcal
			5.298 kcal			5.071	kcal

1. Latent heat of formation of the clinker		487 kcal	22.25%
2. Recovery of energy in the steam			
3. Flue losses			
a) sensible heat of the flue gases 18.0294·0.3·400·0.294	635 kcal		
b) heat of vaporization of the water vapor 1.044·538.8	563 kcal		
	1198 kcal	1198 kcal	54.72%
4. Loss by conduction and radiation			
a) of the kiln	505 kcal		
b) of the boiler			
	505 kcal	505 kcal	23.03%
		2190 kcal	100%

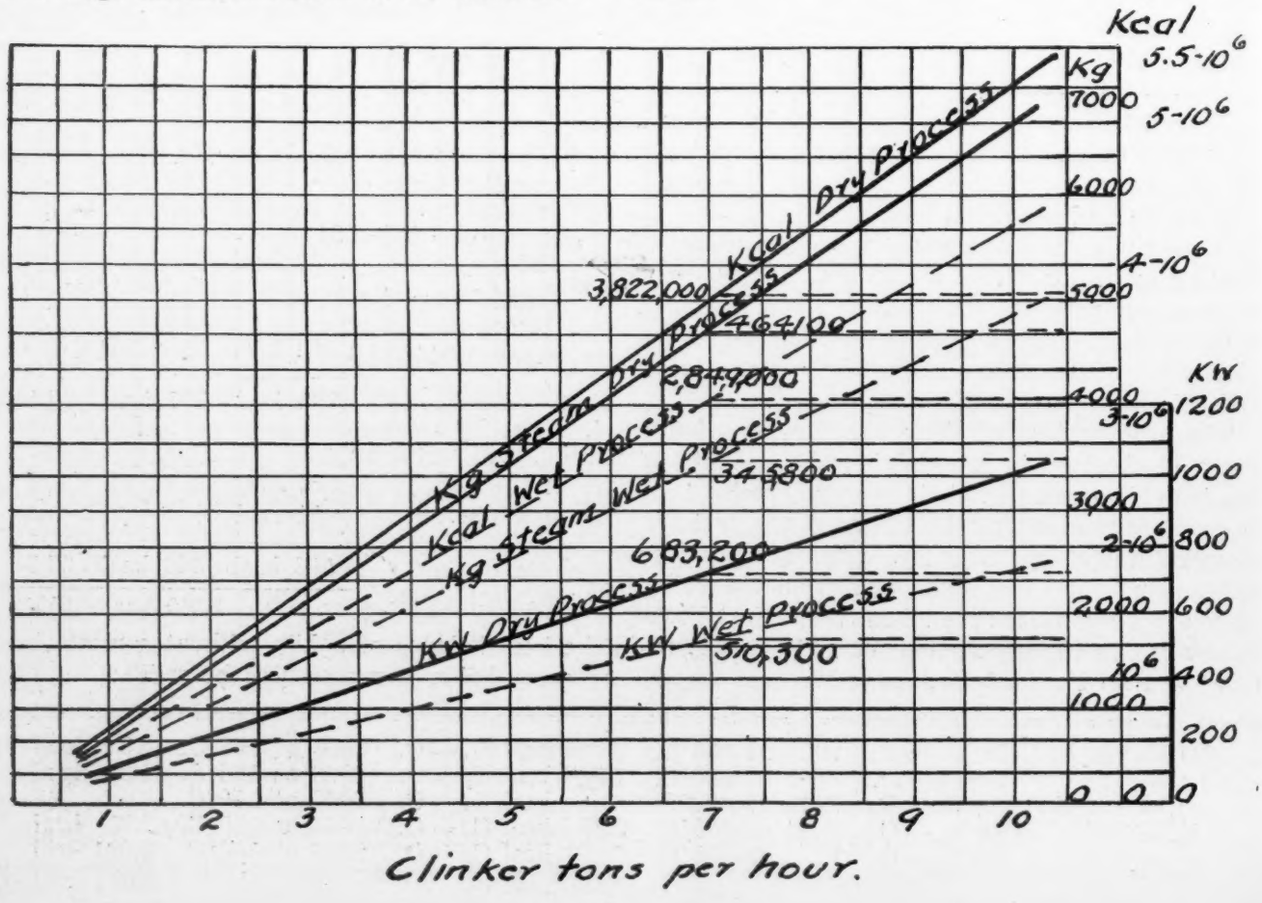
The waste heat boiler thus makes possible a 16% better utilization of the heat consumed. It thus becomes the problem of boiler engineers and manufacturers to deliver to the cement industry boilers which are designed to utilize to the best advantage the special conditions existing with kilns, the installation costs must be as low as possible so that the production of steam or electrical energy is as economical as possible.

Average Values

For rough calculations based on the above method of calculation we have the following values for rotary kilns working by the dry and the wet processes based on one ton per hour of clinker production and represented graphically for hourly clinker production of zero to 10 tons in figure 2.

		Wet Process	Dry Process
1. Weight of flue gases	kcal per ton	407000	546000
2. Temperature of the flue gases, entering the boiler	°C.	400	700
after leaving the boiler	°C.	150	150
3. Drop in temperature	°C.	250	550
4. Average specific heat at constant pressure	kcal per kg per degree	0.302	0.2735
5. Available heat content of the flue gases	kcal per ton	40700	546000
6. Recovery of steam (13 atmospheres pressure 300°C. superheat) at 700 kcal per kg of steam and boiler efficiency of 85%	kg per ton	494	663
7. Energy recovery at 5 kg of steam per H. P. hour in H. P. hours	H. P. Hours per ton	989	132.5
in K. W.	K. W. per ton	72.9	97.6

Thus for conditions similar to those which we have used to base our calculations on we can recover from the flue gases: by the wet process 70 K.W. for each ton hour clinker production; by the dry process 100 K.W. per ton hourly production of clinker.



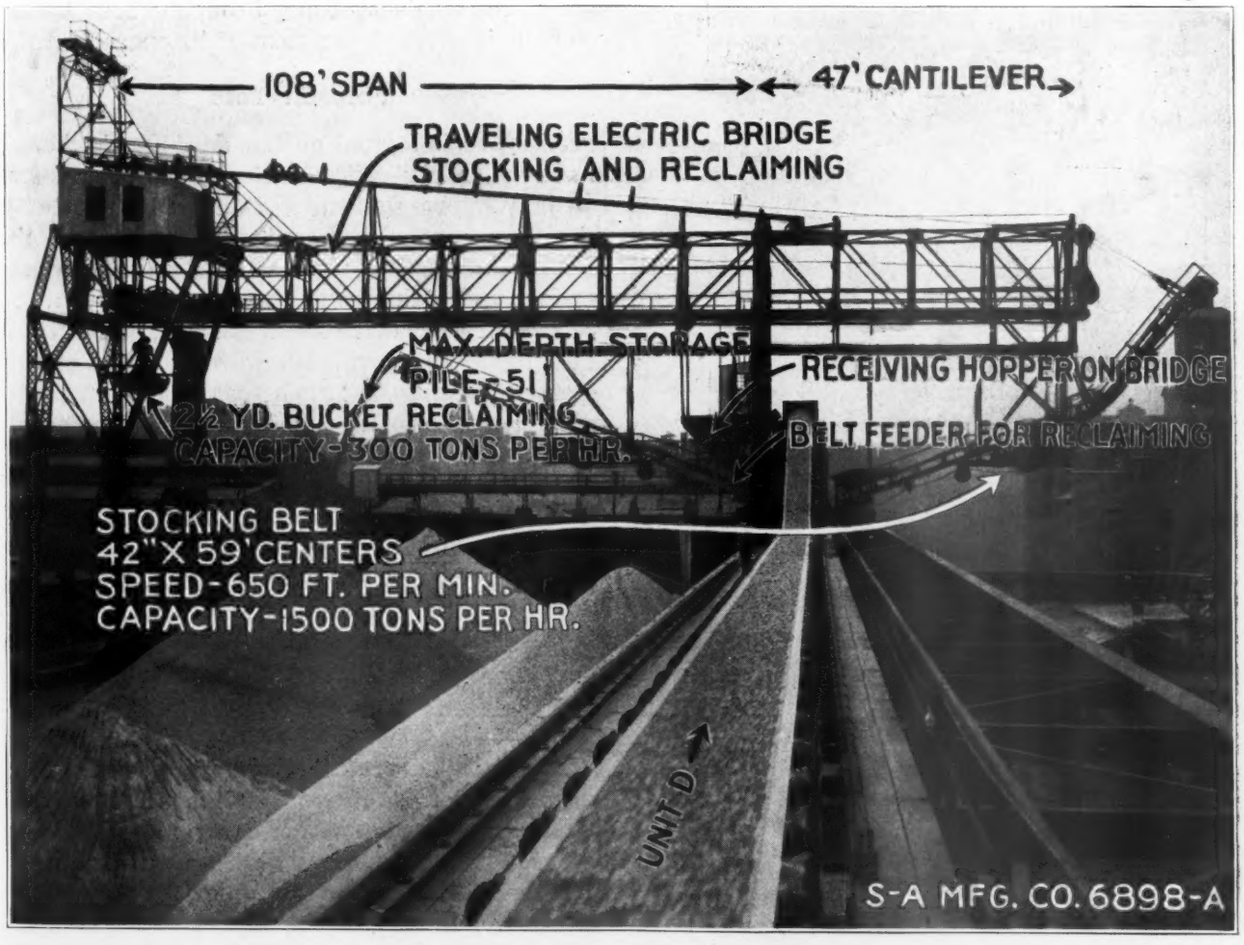
SPEED AND MAXIMUM STORAGE FACILITIES COMBINED IN MATERIAL HANDLING UNITS

By E. D. Roberts

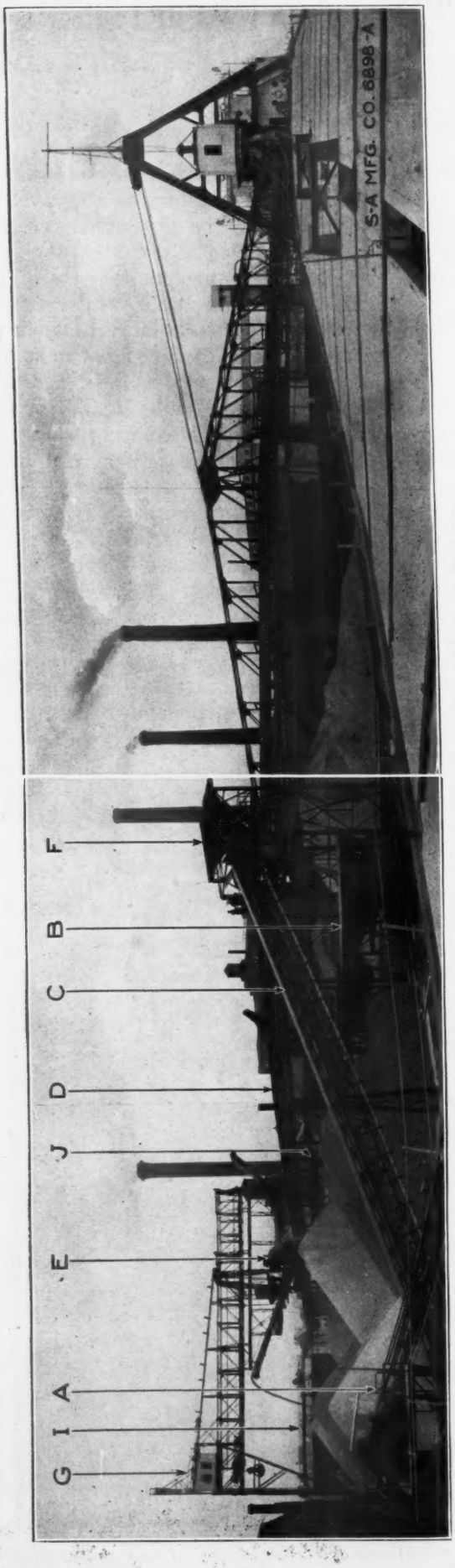
ARTICLES of association were filed at Lansing, Michigan, on April 6th, 1926, for the incorporation of the United Fuel and Supply Company, a new company which had acquired the going business and certain business assets of the old company of the same name, and the Superior Sand and Gravel Company. In addition to these two main units, certain business assets formerly owned by the Birmingham Sand and Gravel Company, the Detroit Steamship Company, and a controlling interest in the Huron Sand and Gravel Company were included in these articles of incorporation. This merger has brought into existence one of the largest building supply companies in the United States with assets around $11,000,000 in which valuation intangible assets such as licenses, trade names, good will, etc., are listed at the nominal sum of $1.00.

Before forming the new company, considerable time and study was given to the problem of handling and marketing the products involved. The J. G. White Engineering Corporation, Inc., of New York was called upon to make a careful study of the industry and of the territory to be served by the proposed company. The production facilities being ample, it was decided to provide a thorough system of distribution throughout the city of Detroit and its suburbs, making up a greater Detroit of 1,500,000 people,—the fourth largest city in the United States, and one of the principal industrial cities in this country. In greater Detroit 18 distributing yards cover the territory served by this company. Eight of these distributing yards are valuable dock sites advantageously located along the city's ten mile industrial waterfronts. Each yard is aided by rail connection so that materials can be delivered by cheap rail rates within a few hundred yards of the point of use thereby cutting down one of the principal costs of building materials; cartage from the rail to the user. Those yards located on the waterfront are further favored by the cheap water rates from the lake points of production.

After deciding the best sites for the territory to



Main Conveyor Delivering Material to Stock Piles



Panorama View Showing Layout of Storage System at Atwater

be served, the management then started on a campaign to increase the efficiency of these yards by the installation of better mechanical equipment at those yards handling a big tonnage or where such changes or betterments could be shown to be feasible from an engineering viewpoint. The company was assisted in this work by the J. G. White Company, Inc., which assisted in the formation of the Company and is still acting for the company in matters where engineering policy or direction is needed.

As a result of this policy, two yards were placed in operation last summer which are very efficient in every way and where a large tonnage is handled. The Fordson Yard in Western Detroit, serves a manufacturing section and a rapidly developing residential district in which many miles of street paving is being laid yearly. The other yard, the Atwater, is located on the waterfront, close to the financial district and the center of downtown Detroit. At this latter yard, old machinery has been replaced by the most modern installation of sand, gravel, and crushed stone handling equipment. The Fordson yard is a new installation where a minimum of machinery handles a large amount of tonnage from the car to the truck; batched or unbatched as desired. These two distributing stations will be described in detail; first, because they are new; and, second because they give an indication of the efficiency being brought about by this company in every department of its operations.

Fordson Yard

This yard is located on the Ford Road where it is crossed by the railroad, close to Michigan Avenue in Western Detroit, and admirably located to take advantage of the rapid development of this part of Greater Detroit. As this was a new site, the first undertaking was the installation of a concrete materials distributing station. Plenty of space has been provided however for the storage of other building materials that will be marketed later from this station. Being dependent upon rail deliveries and yet wishing to eliminate rehandling charges, immense storage bins have been provided. The material is brought over a spur track on a high trestle, the first part being over two sand and gravel bins holding 25 carloads, the next part over bins, holding 4000 tons, located over 28 driveways for direct discharge to where cement is unloaded from the cars by gravity either into the several floors of the warehouse or directly into trucks spotted on the driveways below.

The first bins serve the batching plant, and the sand and gravel is drawn off into Chain Belt inclined pan conveyors which carry the material to multiple spouting above. Two conveyors are provided, one for sand and the other for gravel; the sand conveyor discharging into a two way spout while the gravel conveyor discharges into a three

way spout. The 5 spouts are equipped with 10 Greenville batchers. These batchers, the adjustments of which being made by a threaded bolt, tracts at the same time.

At the end of each of the bins, which feed directly to the inclined conveyors, is a section of bin under which a conveyor belt is operated and draws off the material, by means of gates, and transports it to inclined pan conveyors which discharge into boxes leading to the storage bins above. The twenty-eight driveways under the next section of bins are formed by the trestle supports. The lower portion of these supports is a concrete web upon which are placed the trestle bents extending to and supporting the railroad track and around which the bin structure is placed. Gates placed in the bottom of the bins allow sand or gravel to be drawn off into trucks below.

Throughout this length of the yard is a concrete pavement 100 feet in width allowing any truck to drive through the driveways and make an easy turn in either direction. This is a feature that has made this yard especially appealing to contractors who call for material and do not wish to have their trucks held up due to a congested yard. That there is need for this provision is shown by actual timing and count made by the writer which showed an average of one truck filled and moved every 20 seconds.

A very efficient means for unloading the cars of sand has been provided. A three inch city water main has been carried to the top of the trestle. One and a half inch outlets, leading to a walk constructed along one side of the cars, at the height of the top of the gondola cars, are conveniently placed along the over head bins. Hose pipes are attached to these 1½ inch outlets and provided with nozzles to undermine and wash the sand from the cars. It is therefore unnecessary for a man to take the risk of entering a car and barring down a section of hanging sand. The three-inch pipe line also serves five 3-inch outlets, fitted with fire hoses, as a means for ready fire protection, in addition to the barrels of water which are set on top of the trestle.

At the cement shed is found further evidences of a reduction of man power. After the box car is spotted at the proper chute, a removable chute is placed in position leading from the car to the permanent chute, constructed inside the shed. The sacks of cement are brought to the chute by truck, or hand, and dropped into the chute which they slide down by gravity. The warehouse has two stories and this chute leads from the upper floor to a truck platform on the main floor. However, if it is desired to store the cement temporarily on either floor, a partition is placed in the chute, at the proper place, causing the sliding sacks of cement to stop there. As these temporary stopping platforms are made waist high very little effort is required for the men to remove and stack the cement. Also enough chutes have been provided so that the trucking is only necessary for a short distance. When the cement is being sold from the warehouse, the men bring the sacks of cement to the chute and allow them to slide to the loading platform.

All truck loads of unbatched material as they leave the yard are weighed on a Howe platform scale equipped with a recording beam. This scale is located alongside the office so that the office man can attend to the weighing. However, material that is batched into the trucks is not weighed except when a check is desired on the new adjustment of a certain order. This yard was opened for business on July 3, 1926, and has served through a very busy season and given very satisfactory performance. This heavy business has been caused by the large contracts handled from this plant, one paving contract required a truck load every 60 seconds during each working day. The operation of this yard has been placed in the hands of Mr. E. J. Martin who maintains his office at the yard.

Atwater Distributing Yard

This yard is located on the south side of East Atwater street between Rivard and Riopelle streets on the Detroit River and within three-quarters of a mile of the Detroit City Hall. The property has approximately 250 feet of dock frontage and extends back about 500 feet and for years has been one of the important downtown yards of this company. On account of the value of this centrally located property it was of the utmost importance to adopt a system giving the maximum possible storage capacity. With this as one of the most important features a new idea in the storing and reclaiming of this material has been developed. The use of traveling bridge with stacking conveyors for both storing and reclaiming in conjunction with a trunk line belt conveyor was adopted and arranged, so that in the future a second traveling bridge, combined with a second trunk line conveyor, can be installed. This makes it simple, when the demand comes, to double both the unloading and reclaiming capacity. This also makes it possible to reclaim different size material and mix at will. Another important feature presents itself; the fact that all the stored material can be reclaimed by the bucket on the bridge. In other words, there will be no dead material stored on this valuable property. All of it can be reclaimed and placed into position for loading by gravity to the trucks or to railroad cars for rail distribution.

The United Fuel and Supply Company is the largest building supply organization in Michigan and one of the largest in the country. They handle a complete line of building supplies and in the City of Detroit have a number of their own screening and washing plants, combined with this a fleet

of sand and gravel boats for supplying river sand and gravel to this market.

Mr. C. N. Ray, when president and general manager of the United Fuel and Supply Company, conceived the idea of equipping this Atwater Street Yard, in order to handle with quick dispatch the great volume of material they must deliver to the downtown section. The total live storage capacity with the system under construction will be approximately 135,000 tons. The unloading capacity from self-unloading ships is at the rate of 1,500 tons per hour. The reclaiming capacity in their bins or chutes for immediate discharge to trucks is approximately 2,500 tons.

Self-unloading boats, which are used for transporting crushed rock from quarries in the north, can discharge either to a movable hopper which is the dock hopper, or a hopper which is located at the receiving end of the trunk line. This arrangement allows for great flexibility in the location of the self-unloading ship. The boom from the self-unloader can discharge at any point along the face of the dock. It is not necessary to hold to any fixed location except when discharging material. This is a very important feature because the dock frontage is not sufficient to accommodate the full length of a modern self-unloader, and if boats were tied up at adjoining docks it might not be possible to discharge at a fixed point. The arrangement adopted has overcome this difficulty and the moving crane also makes it unnecessary to move a non self-unloader to get from hatch to hatch.

The units in this storage and reclaiming system are indicated in the illustration accompanying the article and are as follows:

A—Dock conveyor. 42 inches wide and 240 feet centers.

B—Movable dock hopper. 18 feet square with feeder 48 inches wide.

C—Inclined cross conveyor. 42 inches wide and 124 foot centers.

D—Trunk line belt conveyor. 42 inches wide and 440 foot centers.

E—Steel frame tripper.

F—Loading hopper from conveyor "D."

G—Traveling bridge for Gantry crane equipped with 2½ cubic yard bucket.

H—Motor generator set.

I—Bunker conveyor. 42 inches wide and 130 foot center.

J—Mill bin sand conveyor.

K—Steel storage bins. 2 feet wide by 98 feet long.

The horizontal belt conveyor "A" travels the complete length of the water front and can be loaded at any point by the 18 foot movable dock hopper "B." The conveyor "A" loads the inclined cross belt conveyor "C" which elevates the material and discharges to the trunk line conveyor "D." Conveyor "D" runs the complete length of the yard and can discharge in any of three ways as follows:

(1) Over the head end of belt conveyor "I" to the steel storage bins "K" for immediate delivery.

(2) By tripper "E" to belt conveyors "J" to sand bin.

(3) By tripper "E" to either or both inclined stocking conveyors which are carried on the traveling bridge "G," one on either side of the trunk conveyor. Material can be delivered to any storage pile in the yard by moving the bridge to the desired point and discharging the trunk conveyor to either or both stocking conveyors.

The steel live storage bin has seven compartments for sized material. Each compartment has a series of rapid acting gates for unloading and trimming trucks quickly. The stock piles are arranged to give an unusually large storage capacity in a restricted area. Materials may be reclaimed from stock piles by traveling bridge "G" with a 2½ yard grab bucket and delivered through a hopper and feeder on the bridge to the main conveyor, to the bins, railroad cars or to a separate conveyor to the sand bins. Material can be reclaimed at the rate of about 300 tons per hour.

The bridge is a steel structure spanning one row of storage piles. It has a boom extension which serves a second row of piles. The total travel is about 335 feet. In storing, the main trunk conveyor delivers when stocking to either one or both of two inclined stocking conveyors which are carried on the bridge. These two conveyors pile the material to a height of approximately 50 feet. In reclaiming, the 2½ yard grab bucket takes its load and discharges over a center hopper that feeds back to the main beet conveyor. All controls for the bridge and various equipment are conveniently located in the operators cab.

The material handling systems at the Atwater dock was designed and constructed in the shops of the Stephens-Adamson Manufacturing Company. All conveyors are of the belt type each independently driven by electric motor. Primary current is brought to the plant from the Edison power lines. Motor generator sets have been installed for the operation of the bridges. About 430 h.p. of motors are used and are of Westinghouse manufacture.

Mr. James D. Kennedy, formerly president of the Superior Sand and Gravel Company and a man who has had experience in the building supply field in Detroit over a long period of time, is president of the new company. Mr. George H. Hutchins is the general manager, having come to the United Fuel and Supply Company from the Semet Solvay Company of New York where he was assistant to the president in matters of general company administration.

TRANSPORTATION IN THE QUARRY

By R. N. Van Winkle

TRANSPORTATION in its broad sense as applying to nations or countries is, in reality, civilization, as transportation and civilization can be measured by the same yardstick. Show us a nation or region with a highly developed, adequate transportation system and you will also show us a prosperous, well developed and highly civilized nation or region. China and Africa are backward due to transportation while the United States, due to its transportation facilities, leads the world in cheap transportation, good wages and high standard of living conditions. Due to the scientific development in our country of transportation, our railroads are today able to haul a ton of freight a mile at about 1/300th of the wage of the average day laborer, while England, France and Germany have been so far only able to reduce this to 1/60th of the value of a day's labor. You may say labor is cheaper in those countries, and this is true, but transportation costs are nevertheless higher. The same general rules as apply to nations or regions applies to quarries and open pit mines as far as transportation is concerned, for show us a quarry or pit that has developed an adequate transportation system and you will show us a progressive, intelligent operation with low transportation cost. On the other hand show us an operation with poor facilities or inadequate facilities for transportation and you will be showing us an operation which is backward, where labor is poorly paid and transportation cost extremely high. Transportation is the key to development not alone to nations or regions but to quarries and open pit mines as well.

Transportation, maybe better called industrial transportation or haulage, is probably the greatest governing factor in a going quarry as far as operating and production are concerned. Transportation in the broad sense embraces motive power, cars, tracks and in fact all facilities necessary to the furnishing of transportation, but the intent of this article is to deal more with tracks and track layouts and the handling of transportation units in quarrying and open pit mining than the motive power and car angle of the subject. The reason or necessity of a transportation or haulage system in a quarry is to furnish a method of transporting stone or rock in its raw or unfinished state after drilling and blasting, from the point of loading or origin to the mill or crusher, where it is to be crushed, screened, washed, or in other words, manufactured or prepared into a salable product. Quite a few methods of transportation have been used for the above purpose in quarries and open pit mines, but under conditions adapted to their use, tracks, cars and locomotives have no equal because this method of transportation or haulage is cheaper than any other kind of material-hauling equipment.

Steam shovels of various types and capacities are today the accepted means and best practice of loading stone or rock at the point of origin. This piece of equipment is probably the most costly piece of machinery to operate in your entire layout, as it requires experienced operators or operator and a constant number of men, so the costs for shovel operations are fixed and go on regardless of whether the shovel loads one ton or one hundred tons per hour. It is quite evident then, or it should be, that to get real efficiency from a steam shovel it must be kept busy loading at all times during the operating period or day.

With the advent of caterpillar mountings for steam shovels the troublesome and expensive moving of steam shovels from one point in an operation to another is being minimized in respect to expense and time. Quite often it happens that the moving of a shovel or loading unit is accomplished quicker than anticipated, or to put it in other words, the estimated time in moving is materially reduced and one finds himself ready to begin loading with no track or transportation system ready. This condition is quite often the case as the writer has observed from personal experience, and in backing up a shovel or moving one to a new point of loading in a quarry or pit it is as a rule the tracks or transportation system that is not ready, which means delay and a thing which should not occur, but if it does it should occur only once before a remedy is forthcoming. To accomplish the constant operation of steam shovels, efficient and adequate transportation is the key, or ruling factor of your operation, as a constant flow of empty cars must be going to the steam shovel for loading which means a constant flow of loaded cars must be hauled to the mill or crusher, made empty without delay and started on the return trip. It is only through a dependable transportation and hauling system that the costly seam shovel can be kept producing.

It is a peculiar thing, but nevertheless true, that as a usual thing plants, that is to say, crushing and screening plants or mills, are way ahead of the quarry or field in production capacity. This condition can doubtless be attributed to the fact that plants or mills can be definitely worked out and planned on paper, crusher and screen capacities as well as all other mill details can be fairly accurately obtained or arrived at before hand while field or quarry operations are continuously changing and no definite or fixed policy can be strictly adhered to except in a general way, as field or

quarry conditions and details change more or less with each day's operations.

The money in the quarrying or open pit mining industry is made or lost in the quarry, field or pit, and not in the mill. Possibly you will not agree with this statement; but your mill can only produce what your shovel or shovels load and your transportation facilities can haul. Your mill and output are absolutely dependent on these two factors irrespective of how you figure it. As stated above the efficiency of a steam shovel or shovels is dependent on its being kept continuously operating which means adequate car supply which in turn hinges entirely on transportation.

Good track is a blessing to any operation, cost what it may; it may cost you far more not to have it. Good track can only be made of good material and good workmanship after it is once made and properly ballasted and aligned, even if stone must be taken from your bins for ballasting purposes. Track must be properly maintained. Derailment of cars and locomotives are not only delays to your transportation and haulage systems, which means curtailed production, but are costly in requiring repairs to locomotives, tracks and cars. Keep this constantly in mind that time is a big factor in quarry or open pit transportation. For instance, if a carload of stone enroute from the shovel to the mills is derailed, make an honest attempt to rerail it,—if necessary equipment to do so is handy,—but if it can't be done quickly dump the contents of the car and make another honest attempt toward rerailment and if this fails turn the car over clear of the track so there will be as little delay or congestion as possible to your entire system of transportation. Maybe, in your travels, you have witnessed steam line railroads cleaning up main line wrecks where they deliberately set fire to the wreck or roll car after car over an embankment or into a field. This is done for one purpose to save time and delays, relieve congestion and get the entire transportation system functioning; it is expensive, no question, but good practice, and can be and should be followed in so far as practical in quarrying and open pit operations.

As to width or gauge of tracks. Narrow gauge track has come to be known as 36 inch gauge track, and standard gauge is standard in the United States, being 4 feet 8½ inches. Of course, you will find in operations such as this article covers, tracks with gauges ranging from 24 to 42 inches, but stay clear of these odd gauge tracks as they are not recognized standards and only mean trouble when you attempt an interchange of equipment such as cars and locomotives. The two recognized standards of track, narrow gauge and standard gauge, both have their advantages and disadvantages. Narrow gauge track is cheaper and easier to build, is easier to throw or shift and permits of sharper curves, lighter rail and shorter cross ties. Standard gauge track has great advantages in that it offers, on account of its width, more stability to engines and cars rocking back and forth, thereby eliminating the possibility of derailments. This gauge of track also offers great possibilities of free and unrestricted operation over racks in your railroad and loading yards in and about your crusher or mill and is a track over which your steam shovels, provided track type are used, can move back or around at will, a thing or things not possible with narrow gauge track. Standard gauge track is not practical in every operation but where it can possibly be used it is recommended and should be given preference. Bear in mind, too, standard gauge track permits of heavier and bigger cars and locomotives which means more tonnage transported per train or car trip, meaning less trips and less trains, meaning less possibilities of derailments. Derailments are in the majority of cases directly traceable to poor track and are costly for more reasons than one, as has been set out earlier in this article. The writer personally knows of one operator who has not had a derailment in quarry during the 1926 season, still he produced and transported by dinkey and cars, 155,000 tons of stone. On the other hand the writer took over an operation some years ago and had 44 derailments the first day. Good track was the difference and if it were possible to compare the operating costs of these two propositions intelligently, the above conditions would there be reflected very distinctly.

While locomotives or motive power was a subject eliminated from this article, it is a hard matter to pass it by without leaving just one thought and that is the adaptability of the gasoline locomotive to this industry. This type of motive power is coming to the front and very rapidly; it is cheaply operated as to fuel, repairs and labor, and anyone contemplating the purchase or change of motive power will do well to give serious consideration to the proper make, weight and size of gasoline locomotives or motors. Should future gasoline supply be a question in your mind the writer wants to quote on this an authority, whom he thinks hits the nail squarely on the head—"Gasoline users need not be alarmed; for we are nowhere near the point of exhausting the supply of petroleum as now obtained, while also we have stupendous resources of oil shale, and ample cause to believe that automobile fuels can be produced from coal and other substances."

A good transportation system in the quarry or open pit mining operations is very elastic and with sufficient trackage and sidings trains of loaded or empty cars can be dispatched to the point needed almost at will by a competent yardmaster, despatcher or transportation director, or whatever you choose to call him. He should have full authority over all train and engine crews and be likewise held responsible for keeping empty cars at

the loading points and loaded cars at crusher or bottom of the incline. With proper supervision in this branch of the operation many things can be tried and worked out, which will be quite advantageous, such as loading and transporting during the noon hour, or loading and transporting say 10 hours a day while the mill or crusher works only 8 or 9 hours, for bear in mind, as a usual thing, as stated before, crushing plants and mills are way ahead of the field or quarry in production capacity and by such practices this gap can quite often be closed. A good transportation or haulage system properly manned and supervised acts as a safety valve to transportation and haulage congestion.

The best or most efficient track system for any particular operation is a question that cannot possibly be attempted in an article of any sort as every operation offers its peculiarities which can only be treated or solved by a first hand study of the conditions right on the job itself. Grades and curves usually have great bearing on this question. Some operators prefer a circle system of trackage but there is hardly anything to be gained by stating preferences as conditions govern this too thoroughly; for a track layout or system that is applicable to a hillside proposition, has little or no relationship to a pit operation. It will, therefore, suffice to say that in building a track system, bear in mind to build so that every part of your operation to be worked is easily accessible. Provide two ways, if possible, to serve each loading unit, build sidings or run around tracks enough to have meeting points for trains to secure constant movement of all trains and sidings or spurs for repair and storage of cars and locomotives when not in use. By constant application to track layouts each day will bring new visions of the possibilities for positive progress, betterments and shortcuts in transportation problems in each individual operation.

A great many quarries and open pit mines make use of inclines to get loaded cars up to the initial crusher level and while an incline may not be an accepted part of the transportation system, it is an element that has a great bearing on it and is a factor that must be considered, for it is the neck of the bottle, it might be termed, through which your transportation system must function. Originally various makes of friction hoists were the most common means of pulling cars up single track inclines but with the advent of electricity into this industry, friction hoists are being supplanted in modern crushing plants and mills by electric hoists equipped with varied stop controls. Moreover in recently designed large production operations the single track incline is giving way to the double incline track which allows of a loaded car being pulled up while an empty car is being let down. It is not the idea to leave the impression that inclines are to be recommended as there is the side-dump method where a train of cars drawn by locomotives pass alongside the initial crusher and dump direct into it. Stone skips are sometimes used and the writer recalls one operation where stone for the initial crusher was loaded on flat cars and plowed off by a power plow directly into the crusher. If, however, an incline is used, ample consideration should be given speed of hoist, length and pitch or angle of incline and most important to be sure to have a hoist of ample size and capacity to provide for future developments in increased capacity, or the quarrying or loading of a lower strata of stone for the latter means a longer or steeper incline.

The actual unloading or dumping of cars is receiving consideration in the industry today. End dump cars, as far as dumping is concerned, are pretty well, and we might say easily taken care of, but many devices, home made and otherwise, are being used for the handling of the side dump equipment. It will pay all of us to keep our eyes open to this car dumping proposition, making and encouraging new methods as car dumping with speed and accuracy and righting car again has a great bearing on efficient transportation.

It is the writer's hope that in writing such articles as these that he may by chance bring to the attention of the busy executive or operator some new angle or bit of information on one of the many phases of quarry and open pit mining operations. The picture I have drawn in the above article in reference to quarry transportation is of necessity a rough and rather broad picture lacking in many details, but if I am successful in giving you even one new thought or idea, or even aroused your interest in your transportation or haulage system, I have been successful in my desire and you will take the time and opportunity to fill out the picture and supply the missing details in your particular operation or operations. We all have changes and improvements that could doubtless be made to advantage and it is the writer's hope that in writing such articles, not that he is a bit smarter than lots of other operators, that he may by chance give a new vision of the possibilities in our particular industry or line of endeavor. For if our life's work is quarrying and open pit mining, the fact is, the more we know about it and the more we accomplish or do in it, the more interesting life is going to be for us.

The writer moreover is trying to give in such articles as this his experiences as an operator and his thoughts and ideas on the subjects and while they may not have universal approval and not coincide with your views or experiences, such articles will, if written by more executives and operators engaged in the industry, help and strengthen our industry. There can be nothing but good, as the writer sees it, come from an interchange of thoughts, ideas, experiences and speculations in a spirit of entire frankness and sincerity.

TRANSPORTATION PROBLEM AS RELATED TO THE SAND AND GRAVEL INDUSTRY

By W. J. McGarry
Manager, Open Top Car Division, American Railway Association*

PERHAPS it is unfortunate that we do not have commodity statistics so divided as to specifically cover sand and gravel. We can, however, obtain a very good picture of this industry through reports made to the Car Service Division on carloadings of sand, gravel and stone and the data on this class of carloading indicates 1926 to have been the best year in point of carloadings in the history of your industry. To compare shipments of these commodities for a few recent years our records indicate the loading in round numbers of one million, two hundred and fifty thousand cars in 1921. The data for 1922 on a comparable basis is not available, but the figures we have indicate that it probably did not exceed two million cars. In 1923 the loading increased to 2,062,000 cars; in 1924, to 2,196,000 cars; in 1925 to 2,382,000 cars, and in 1926, the banner year, our records indicate the loading of 2,614,000 cars of these commodities. This means an expansion in the business which you gentlemen represent of around 109 per cent in 1926 compared with 1921, and this is the more remarkable when we set this figure up beside the increase during the corresponding period in all revenue freight loadings which showed an increase in 1926 over 1921 of only 35.4 per cent.

The performance of the railroads in handling in 1926 the largest volume of tonnage ever transported with practically little or no car shortage becomes the more remarkable when we find that this greatly increased tonnage was handled with practically no increase in the number of freight cars. In the field of the open top car there was actually a slight decrease.—there being an ownership on Class I roads of 1,002,246 open top cars on January 1, 1920, and only 996,752 on November 1, 1926, a decrease of six-tenths of one per cent. The fact that the railroads, however, have been constantly on the alert to increase the carrying capacity of their cars is indicated by the fact that the average tons per car carrying capacity on open top cars was 48.9 tons on January 1, 1920, and 52.5 tons on November 1, 1926, an increase of 3.6 tons per car, or 7.4 per cent. Even with this increase in carrying capacity it is quite apparent to any of us who have given thought to the situation that this transportation accomplishment on the part of the railroads would not have been practicable without the close and intelligent cooperation of shippers and receivers in the matter of heavier loading of cars and more prompt release of equipment generally.

One of the important trends in the Sand and Gravel Industry is indicated by the fact that at one time, not so very far in the past, the high-side open top car of dump and hopper construction was considered exclusively as a coal car. Improvements in plant and unloading facilities on the part of the Sand and Gravel Industry have changed so that now there is practically no distinction in the use of the high type cars as between shippers of sand and gravel and coal.

We are, all of us, more or less familiar with the experience gained under the operation of "priority orders" issued during periods of the past and you gentlemen know better than I can tell you how detrimental those orders were in their effect on the Sand and Gravel Industry. When I was privileged to appear before the members of the National Sand and Gravel Association in annual convention assembled at the Chase Hotel, St. Louis, January, 1924, I made the prediction that another shortage of open top cars would not be experienced for a period of five years at least and so far that prediction has held true. We were, it is true, hard pressed during the period October 1 to December 1, 1926, to provide a car supply adequate for all requirements in view of an increased loading of sand, stone, gravel and other commodities requiring the use of open top cars. No shortages existed except in isolated instances for temporary periods, and that the requirements of the Sand and Gravel Industry were very well taken care of during that period of exceptionally heavy demand.

What has been done in the past is certainly possible of accomplishment for the future and with the continuation of the splendid cooperation which the railroads are receiving from the public generally, including the members of the National Sand and Gravel Industry we have every confidence that the car supply and transportation service will meet all of the requirements which may be placed on it. I have referred before to the cooperation of the Sand and Gravel Industry and of the public generally, in the remarkable tonnage handlings of the railroads in recent years. I wish to tell you something of the manner in which the public has been apprised of the need of such cooperation, and the method in which it should be extended.

Most of you are no doubt familiar in a general way with the organization and work of the American Railway Association and of our own branch, the Car Service Division. You know that we are the

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joint representatives of the railroads in the handling of matters of car distribution and supply; you know that we have harped for a number of years upon the question of heavier loading and prompt unloading of equipment. To bring about the desired results along these lines we have always endeavored to reach the men actually capable of giving such results, that is, the shipper and the receiver. The interest of the shipper and receiver and of the public generally in the successful working out of car distribution and supply problems is just as great as that of the railroads. On the face of it it might seem that a wholly satisfactory solution would be the building of more and more cars until there were enough owned by the railroads to handle every possible demand for loading, regardless of how light the load per car might be or how much delay occurred in returning the car to the loading point for a fresh load. No one is in a better position to realize the fallacy of such reasoning than the men in your industry, using, as you do, costly machinery which must be kept constantly productive in order to show a profit. The railroads are in exactly the same position. The purchase of large numbers of freight cars at an enormous cost to lie idle during periods of low demand would represent an enormous capital expenditure upon which interest must be paid, and such payment must eventually come from the users of railway transportation. The proper and efficient method, of course, is to so speed up the handling of cars by the railways and to bring about such capacity loading as will enable the railroads to handle the tonnage with the least practicable investment in rolling stock.

Our efforts to reach the shippers and receivers on problems of this nature met with some success prior to the war. During the war, of course, everyone was willing to do his or her part and the only difficulty toward securing the desired results was a lack of adequate organized contact with the various units of industry, through which the necessities of the situation could be brought home to them. Following the war the railroads began casting about for a means through which such service problems could be brought home to shippers and receivers and through which problems of industry could be discussed, understood and settled, without the necessity for burdensome and often long drawn out procedure before regulatory bodies. We feel that in the Regional Shippers Advisory Boards—with which most of you are no doubt familiar—this necessity has been largely met. I would like to speak to you for a moment upon the Boards and their accomplishments.

There are now fourteen of these organizations, covering the entire United States. The movement had its start in the Northwest in 1923. The railroads in that section, following their return to private control after the trying experience of the war years, were in bad repute, as was generally the case with the railroads throughout the country. Car shortages came regularly with the periods of peak production and there was little in the way of active cooperation from the shipping public to assist the railroads in working out their troubles. In such a setting the Northwest Regional Advisory Board was born. We had a joint conference of all Boards in Chicago January last and I want to quote to you briefly from the report of the Chairman of the Northwest Board as to the troubles surrounding the organization of that Board and the manner in which these troubles are worked out.

"If necessity is the mother of invention the necessity in this case was great enough for a mother and father both. With farmers and shippers most thoroughly embittered; with railroads and transportation officers deadened by abuse and vituperation, it is small wonder that the early efforts, begun in December, 1922, to get these interests together did not prove enthusiastically successful. The first effort to get together met small response. A tenseness and reserve characterized the actions of the individuals making up the groups representing the shippers and the carriers. At any minute, nearly every member, composing either group, was primed and ready to inform the other group, individually or collectively, in language unrestrained, in just what esteem he and his group were held and where they could go. Little or no progress was made.

"Another meeting was called to meet in Minneapolis, January 16, 1923. Those who attended the first meeting had some time for reflection. The more they thought the better they felt toward the idea of a possible getting together. They told their associates and when they came together the second time the ice was broken.

"A permanent organization was formed and thus began the first of the so-called Regional Advisory Boards. This was purely an experiment. While apparently the lamb and the lion had lain down together, this was at that time more apparent than real. Mutterings were still heard. Many very pertinent questions were asked. Because I—a farmer—had been chosen chairman, some farmers began asking what was going to be done. My answer was a strong invitation to attend our meetings and sit in on the plan. Nothing would be concealed. Every card would be on the table face up. Every interest was guaranteed perfect fairness and equality. The slate was clean. All records would start from there. Any man or group, whether of shippers or different interests of shippers, representatives of the carriers of divisions of these representatives, would all be accorded the same consideration and full and complete equality. Any one, group or division, seeking unfair advantage would meet with short shrift. Cooperation is what we sought. Every interest affected was approached

and our plans explained with a very hearty and cordial invitation to sit in and help.

"Thus began an experiment in cooperative effort between groups heretofore with apparently so divergent views that it was regarded as an impossible undertaking and one destined to failure.

"Three years of operation has shown its worth, shown its effectiveness, shown its ability to help correct some of the most glaring defects in the service of transportation,—and most of these defects in shipping cured by the shipper himself,—until today, from this experiment and its success, similar Boards cover the country, all stressing cooperation and service and all working to a common end to attain this badly needed and much sought after desire.

"What about the carriers and their representatives?

"They have not only met every demand of our Board but have gone far beyond its demand in providing service. When the roads' own equipment was thought to lack ability to carry the load new equipment and power was provided without stint. 'Service' became the slogan of the carriers and today in the Northwest the most outstanding accomplishment of all our industries is the manner and character of service now being rendered by the railroads. This service so greatly outstrips any ever heretofore given in this area that it forbids comparison."

As I said before, we now have, counting the Florida Unit of the Southeast Board, fourteen Boards, covering the entire country. It has been possible through these organizations to settle amicably hundreds of problems which, under the old regime, would no doubt finally have been the subject of expensive and embittering litigation before the courts or regulatory bodies. It is impossible to estimate the actual savings to users of transportation which has accrued through this informal settlement of their shipping problems. We do know that the Boards and their works have been responsible in no slight measure for the very satisfactory transportation situation which has existed during the past several years. We do know that this satisfactory and efficient transportation has enabled a very material reduction in stocks and inventories in practically all lines of business, with a consequent enormous saving in interest charges and a leveling out of the peaks and valleys of production. We do know that the Boards have enabled the railroads to interest the shippers and receivers in their problems, particularly the proper utilization of equipment under the Car Service Rules, and the heavier loading and prompt release of equipment. In the case of threatened car shortages we have been able to reach the interested shippers and receivers promptly through the Board organization with information as to what should be done in the handling of cars to avoid disastrous shortages.

Whether or not the railroads would have been able to handle the enormous tonnage of late years without the old time car shortages had it not been for the work of the Boards and the cooperation received through them, no man can definitely say. We can simply point to the record breaking tonnages handled by the railroads during these late periods, on the one hand, and to the understanding and sympathetic cooperation afforded by shippers and receivers through the Boards on the other hand, and say that this cooperation and assistance has been a very worth-while factor in the transportation accomplishment.

It is difficult, of course, to imagine the necessity for a large standing army in piping times of peace. We can all hark back to the days before our entry into the Great War and remember the arguments of those who felt that preparedness was an unnecessary expense. We can recall their resounding phrases to the effect that should our country be actually in danger a million men would spring to arms over night. We can also remember the speciousness of this argument as exemplified in our efforts to build up an adequate military organization after we did finally embark in the world struggle. We know now that it takes time, careful preparation and sound building from the ground up to perfect a nation-wide machine of men, money and materials. This lesson is sound when applied to our Regional Board organization. Any argument to the effect that everything is running along smoothly in the transportation machine and that the few days in the year necessary to attend Regional Board meetings and carry on the Board business are not productive of good is specious and should be rejected. No man can say when emergency conditions will arise in our transportation machinery. Strikes, wars, disturbances in production and distribution, sudden expansion, such as in the State of Florida, and other numerous possible causes may easily overthrow the sensitive balance between car supply and car demand, and it is in the foreseeing and preventing of or otherwise by minimizing unbalanced conditions that the Boards can find their greatest field for service.

I would urge all of you who have not done so to become personally acquainted with the Board movement in your own territory, to interest yourselves in the workings of your Board and to attend meetings and contribute your share toward the success of the Board organization. This done, I feel no hesitancy in assuring you that the satisfactory railroad service furnished during recent years will be continued and in all probability further improvement will be noted.

A BETTER RAILROAD BALLAST

By F. J. Stimson
Assistant Chief Engineer, Maintenance of Way, Pennsylvania Railroad*

SUITABLE ballast for railroad maintenance is a matter that has long given the Maintenance of Way man great concern. In the very early days of railroading, any material that was fairly dry and easy to work was used as ballast and thousands of miles of track were put on material, cast up from the sides of the roadbed. This in many places was clay, loam or gumbo and made what we call today "mud ballast." As the first consideration with such ballast was to get the water away from the track as quickly as possible, a "gable roof" was formed of the roadbed material, by bringing it up over the ties at the center of the track to about level with the top of the rails and sloping it then on a plain which would pass through about the bottom of the tie at its end and which was continued to meet the slope of the embankment or ditch, where ditches were maintained. This, by the way, seems to have been the origin of a form of road bed for good gravel ballast which is still in use to quite an extent. The only explanation to be given for this, is power of habit.

At a time when keeping water from soaking into the roadbed was of prime importance, the "gable roof' form of dressing track was very properly devised and used, but now when the material selected especially because it will let the water drain through readily is used and dressed in the same general shape as mud ballast, thus forming a weakened track support—one which invites center bound track—the original reason is lacking and nothing but blindly following past practice can explain it.

Pardon this digression from the subject of ballast, but the idea of building out of material selected especially for its free draining qualities, a roof for carrying off water, has long struck me as fantastic in the extreme. While the old mud ballast gives fairly good results under favorable conditions, during wet weather and especially during alternate thawing and freezing, the track conditions become frightful. It was the common practice during such periods to block up bad spots in the track on boards, slabs, fire wood (engines were quite generally wood burners and wood was easy to get) and even by using full sized ties under the track ties.

One of the ancient stories has it that when lowering the grade through a cut which had always been troublesome to maintain, enough ties were removed to relay the track. This may be taken with a grain of salt, but no one will question the statement that track conditions were deplorable and the track man's job was no sinecure. Quite early in the maintenance game, gravel was found in the natural deposits, was used as ballast and the beneficial effect upon track maintenance was very marked. In the earliest use of bank gravel for ballast, a list of 5 inch to 6 inch was looked upon as very good, but very often the whitewash method was used—only enough gravel being unloaded to cover the surface of the roadbed to a depth of one or two inches, this probably because of belief in the power of suggestion.

The use of too light a lift on ballast was a very common error in the early days, and it is to be feared that it is still all too common. Within a year or so after being applied, such ballast has been driven down, mixed with the sub-grade material and has become worthless as ballast. Another light lift is given and the process is repeated. The natural result of this is that within a period of comparatively few years sufficient ballast has been used to obtain good results, but there have been actually secured very indifferent results. This because of the mixing of the gravel with the foul material of the sub-grade, which mixture is little better than the sub-grade material itself.

Much the same result has been observed by many of you when a driveway is being made across a stretch of loose sand. Put on 10 to 12 inches of engine cinders (I know of nothing better for the purpose) and you will have a fine solid driveway which will stand up under very severe use. Use five or six inches and put it in service and at no time will it be a good road, and after having been used for only a short time, the sand and cinders will be pretty thoroughly mixed and the roadway will be as heavy as though no cinders had been used. Put five or six inches more of cinders on and you repeat the failure. Wheels cut through, bring up the loose and sandy mixture, mix it with the new coat of cinders and you again have a heavy sandy roadway. Even where the lift given was enough to prevent the ballast from actually mixing with the sub-grade material, it was found that under the constantly increasing axle loads the ballast did not hold up and from the early 6 or 8 inch lift, we find our roads going to a ballast program calling for 12 to 14 inches.

But it was found that depth of ballast alone did not get the desired results. Even on the greater depths of ballast we would surface and line our track carefully, trains would glide smoothly over it and we would congratulate ourselves that we had a fine piece of track. Then after a few weeks' use, we began to hear invidious comments made by

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our traveling public. We would hear some rotund occupant of a Pullman smoking compartment say (it is generally the well kept ones who voice their complaints most vociferously), "Did you ever know anything like that ride last night? We might as well have been on the ties—the way we bumped along." Other comments which would come to us would be equally soothing. To overcome such track conditions, a better quality of ballast was necessary.

Another phase of the ballast question is dust. There is no one here—I will venture to guess—who has not experienced the annoyance, yes, the actual discomfort and even distress of a ride on a train over a piece of track that was ballasted with dusty ballast. Take a season that is dry; a day that is hot; a journey that is several hours long; a track that is on dusty ballast freshly worked, in putting in ties or surfacing out of face; a train that runs at a speed of 55 miles per hour or better (below that speed dust does not fly badly) and towards the end of your journey you happen to look in the mirror and turn at once to see if the dark chocolate colored face looking out at you is that of the porter who may have come into the room unbeknown to you. But no, he is not there. It is your own well known, but well disguised face that you see. Of course, your face is no magnet—at least for dust—and there is just as heavy a covering of dust on your clothes, partially unseen probably, as there is on your face. To put it mildly, you are not happy over the situation and you are pretty apt to comment to yourself or audibly that you will never travel that route again.

How to eliminate, or at least moderate this condition is squarely before the Maintenance of Way man and just as squarely before you. As the demands for ballast that would maintain a better riding track and give a cleaner ride increased, we began, in order to secure the maximum value from our gravel ballast to put the natural deposit through various forms of preparation. At first we thought we could overcome the difficulty, by limiting the amount of sand and by taking out the coarsest of the cobblestone, but we did not get what we wanted. Washing plants were built and gravel was prepared for use as ballast by washing it to remove the dirt, clay and loam by screening it to control the sand content, by segregating the coarse material, crushing it and returning it to the output for use as ballast.

Our problems were still unsolved. Ballast was produced at some plants and at some pits that had too much or too little coarse aggregates; too little or too much fine aggregate; too much dirt, clay and loam remained in the ballast. In short, it was not a uniform or satisfactory product and it became apparent that a specification to cover the preparation of gravel for ballast—one that would fix the general portions of the segregates—was necessary.

The outcome has been the adoption by the A. R. E. A. as recommended practice of: First, a roadbed section calling for 12 inches of sub, and 12 inches of top ballast measured from the bottom of the tie. Second, a set of specifications for washed gravel to be used as top ballast setting forth the proportions of the various sized aggregates that must be provided and limiting the maximum percentage of sizes that are not wanted, but which will be tolerated as coming within reasonable commercial practices.

When we recall the increase in the weight of engines and loaded cars since railroading began, the great need for better ballast material can readily be understood. It is but little more than two generations, since our first railroads were built. I say two generations, for the reason that in 1846—twenty years after the first railroad was constructed—my father began his work in the field of railroad construction and maintenance and there was a break of a little more than a year between the end of his service and the beginning of mine—and I hope I am not at the end of mine yet by several years. In those two generations, what changes!

Starting with cars so light that one corner could be almost lifted by a good strong man, we are now carrying on our tracks axle loads of from 65,000 to 75,000 pounds. And what a tremendous increase in the speed! Then 20 miles per hour was fast. Now, 70 is common, while 80 and 85 is frequently made. Such enormous loads moving at such great speeds mean an almost inconceivable stress upon our track, which must all be absorbed by the ballast we use. Is it any wonder that we insist on our specifications being followed closely? Is it any wonder that we turn back carloads of material that contain too much dirt and loam, too much sand, too much coarse aggregate, or too little, too little small aggregate or too much, that is poorly mixed in the car so that one stretch of track is covered with material in which there is little or no aggregate smaller than one-half or three-quarter inch and another stretch with material in which the aggregate is all or nearly all under one-quarter inches?

True the exact mixture as to size of aggregate which will make the best ballast is not known. The writing of specifications for ballast is not by any means an exact science. But having observed the action of this ballast and the performance of that, having discussed among ourselves as maintainers of the track and with you as experts in the preparation of gravel, the questions as to the best combinations, and having reduced the composite conclusions of our best judgment to certain definite language—and I submit that specification as adopted by the A. R. E. A. leave very little to the imagination—in short it is up to you gentlemen to give us what we want as we want it.

BITUMINOUS ROAD CONSTRUCTION

By R. W. Coburn
Construction Engineer, Department of Public Works, Boston, Mass.*

MY IDEA of a Bituminous Macadam Road is a modern pavement, and it is my belief that this type of road has a wide field for use, wherever trap rock or other suitable stone is available. Furthermore, I believe that in many places it can be built and maintained more economically than any of the more expensive types of modern pavements.

History of Bituminous Macadam Roads

Before going into the details of construction, it will be well to define what is meant by a "Bituminous Macadam Road," and to consider briefly its history. The definition adopted by the Association for Standardizing Paving Specifications is as follows: "Bituminous Macadam Pavements are those consisting of broken stone and bituminous materials incorporated together by penetration methods."

The modern Bituminous Macadam road is comparatively new, having come into popular use during the last fifteen years. Its popularity was due to the fact that the automobile was fast destroying the old water-bound macadam roads and a binder other than dust and water was necessary. To Massachusetts, perhaps, more than to any other State, belongs the credit for pioneer work in this type, and it may be considered pioneer work, for this type was still in its experimental stages up to 1912, at which time the Massachusetts standard type of Penetration was developed. It can be safely said that up to this time heavy asphalts had not been sprayed by distributors under pressure. Lighter materials had been used and the work was done by hand or other crude methods.

The experimental or pioneer work mentioned above was carried on from 1907 to 1911 inclusive, each year showing some new development or improvement. At first, the bituminous materials were used to preserve the old water-bound macadam roads and to lay the dust, but it was soon found that better results could be obtained if the bituminous binder was incorporated into the road itself. The Bituminous Macadam Road that I am going to discuss is a type that was developed in Massachusetts in 1912. It consists of a 2 to 3 inch top or wearing surface of 2½ inch stone, bound with heavy asphalt or tar. This top surface is usually laid on a broken stone base four to five inches in depth, which has been thoroughly rolled and bound up with dust or sand almost like a water-bound macadam road.

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Massachusetts Standard Type

In discussing this modern type of Bituminous Macadam pavement, I shall treat it briefly under the following headings:

1. Materials used in construction.
2. Machinery and equipment necessary for proper construction. (Roller, kettles, asphalt wagon and motor distributor.)
3. Inspection of work in field.
4. Method of carrying on the work.

Materials

The materials necessary for the construction of a good Bituminous Macadam Road are first, a good hard and tough stone; and second, a good grade of bituminous material, either asphalt or tar of the proper consistency. The stone should preferably be a good commercial trap rock or a local stone of its equivalent, having a French Coefficient of wear of not less than fourteen and a Toughness of not less than twelve. It should be available in number 1 sizes, that is from 1¼ inches to 2½ inches. I am going to say more about this stone than I might on another occasion, on account of the fact that it is to you gentlemen and the members of your Association that we must look for the proper stone.

In Massachusetts we allow an inferior stone or local stone to be used in the base course, provided it will pass a French Coefficient of ten and a Toughness of eight, but we call for a higher grade stone or rock for the top wearing surface. It is very essential that we get a clean, uniform product for this top 2½ inch penetration course, uniform both in quality and in size, for if it lacks uniformity in quality it will break up unevenly under the roller and give the same results as if it came non-uniform in size. This means an uneven penetration, causing weak places and fat spots, and a general lack of uniformity in the finished surface of the road.

In order to get the clean uniform stone that is essential for first-class penetration work, I believe 1st: That the ledge must be properly stripped; 2nd: That the inferior stone in the quarry, if it exists, must not be allowed to run through the crusher with the good stone; and 3rd: That the stone must be thoroughly screened in order to remove all the one inch stone from the two inch and to free the dust and dirt from all sizes of stone.

The bituminous material required for this work may be any one of three kinds which shall have certain prescribed properties, and among other requirements must meet the following:

A. Fluxed native lake asphalts shall have a penetration of 120 to 150.
B. Oil Asphalts shall have a penetration of 85 to 120.
C. Tars shall have a consistency of 120 to 180 by the Float Test. (Penetration at 25° Cent. (77° Fahr.) 100 G., 5 c.)

These three kinds are illustrated by their trade names as follows:

Bermudez—A Fluxed native asphalt.
Binder B or C—An oil asphalt.
Tarvia X—A coal tar product.

Machinery and Equipment

The amount of machinery and equipment necessary for this work is probably smaller than for any other type of modern pavement. For that reason it is popular in cities and towns where they do not own expensive machinery. Provided the stone is trucked to the job and the bituminous materials sent out from a heating plant in a motor sprayer, about the only machinery needed on the job is the steam roller. In case the work is to be done at a considerable distance from any commercial quarry, and too far to send bituminous material by truck, then a stone crusher would be needed, kettles in which to heat the bituminous material, a spraying wagon for applying it. It has been my experience that with a trained organization, just as good work can be done with the wagon distributor hitched behind a roller as with the motor-sprayer. I should add, however, that today where work is being done within the trucking distance of a bituminous heating plant, it is cheaper and it facilitates the work if a motor-sprayer is used.

Inspection

The inspection in the field is a most important phase of the work, and it is my opinion that more penetration roads fail because of poor workmanship and poor inspection, than from any other cause. A bituminous macadam road may fail from poor design, because foundations were omitted where they were needed, or the road built too thin, or it may fail because of poor quality or too little bituminous material, but I believe that more failures are due to other reasons, and that the majority of them could be prevented if the inspectors were properly trained in the details of the work.

Method of Construction

The first step in the construction of the penetration road is the provision for adequate drainage. In loamy or clayey soils a subgrade of gravel should be laid, or a stone base on top of about four inches of gravel. In wet and springy ground, side drains should be built with broken stone and open-jointed sewer pipe, or ditches should be provided along the sides of the road in order to keep the ground water out of the subgrade. The elimination of water in the subgrade is very important, and unless bleeders of porous material are built at regular intervals to carry the water out from under the pavement, the subgrade may become saturated and lose its normal bearing power and in cold weather cause heaving or frost action. These bleeders are especially important at low points in the profile, and here they should be built on both sides of the road to make certain that there is no ponding of water under the pavement. Having drained the road and provided suitable subgrade and shoulders, the next step is to roll the subgrade thoroughly with a heavy roller until no settlement can be discerned.

Base Course:—Upon this compact subgrade there is then spread a layer of broken stone, preferably number 1 stone, but if it is necessary to use the output of a crusher, then number 1 and number 2 stone may be mixed, being careful that they are mixed uniformly and that there is not an excess of the number 2 size. This layer should be carefully spread, either from dumping boards or self-spreading trucks, and after rolling should have a perfect cross-section two to two and one-half inches below the desired finished surface. If depressions or high spots are visible, they should be carefully patched or removed, for the more perfect the base is made, the easier it is to get a perfect top surface.

Up to this point no dust or sand binder should have been added, for it is very important to get the maximum amount of mechanical bond before adding the binder or filler, and it is only when the roller will no longer leave its marks on the surface of the broken stone that the stone can be considered thoroughly rolled. In spreading the binder it should be applied in two or three applications, while the roller is working, and in no case should it be dumped on the surface of the broken stone. During the rolling of the base course, it is quite important to roll out on the shoulders for twelve to eighteen inches, in order to insure a strong compact shoulder that won't weaken or settle when the final rolling is being done on the finished surface.

After the base course has been bound up with the binder and rolled until it is thoroughly compacted, it should resemble somewhat a water-bound macadam surface, except it is not bound up so tightly. The surplus binder is then broomed from the surface and the top or wearing course can be spread.

Top Course:—Best results will be obtained in the top course if number 1 trap rock is used, being careful that there is no number 2 or finer stone mixed with it. This trap rock should be spread with a mechanical spreader or from dumping boards with forks, and the dust and dirt, and small stone left on the boards thrown to one side and wasted. This is important, for with almost every truckload of broken stone there is a bushel or more of dirt and small stones, and if this is left in the

road in one spot, as is likely, proper penetration will not be obtained when the bitumen is applied, as the voids will be partly filled with dirt. Furthermore, there would probably be a blot or "fat place" on the surface where the bitumen could not penetrate.

Having spread the top stone carefully from the dumping boards and having done all the patching that can be seen at the time, the top surface should be lightly and carefully rolled, and the patching continued until the road surface looks absolutely perfect. The patching should be done with number 1 stone only, and it is important to do it before the surface is rolled too much, as it is very hard to roll a patch into a well rolled road. The top course is usually two inches thick, but I prefer about two and one-half inches with two and one-half gallon of asphalt per square yard. When the stone is so rolled that the roller does not make a track on the stone, but before the stone begins to break up under the roller, the top course is ready for the bituminous material.

The Penetration:—The engineer in charge of the bituminous work should now carefully inspect every square foot of the surface where he intends to apply the asphalt, to see that there are no depressions and that the stone is clean and of proper depth. Special care should be taken to see that the edges of the road are straight and neat, and that dirt from the shoulders has not been allowed to enter the top stone, for if the edges are neglected they will be the first to ravel. He should then see that the bituminous material is of the proper temperature and that all the nozzles of the sprayer are absolutely clean.

Having looked after the details, word may be given to go ahead and apply the bitumen. If asphalt is used, it should be heated to a temperature of about 350 degrees and applied under a pressure of sixty pounds per square inch, at a rate of two gallons per square yard, either with a motor-distributor or with a wagon-sprayer, but not with a single nozzle. If the distributor streaks and does not apply the asphalt uniformly, it should be stopped at once and either removed from the top stone while the nozzles are being cleaned, or a trough should be put under the nozzles while they are dripping and being cleaned.

When the load is being applied, one or two men should walk along on either side of the sprayer, and whenever a puddle or fat spot is seen a pick or light-pointed bar should immediately be used to open up the stone, and if possible, let the asphalt down into the stone to prevent a puddle. If this is not done in a few seconds after the asphalt is sprayed, the asphalt will have cooled and then the only way to correct the defect will be to cut out the top stone, replace it with clean stone, re-roll and penetrate again.

After the load has been distributed on the road, and before the asphalt is covered with pea stone, the engineer should carefully examine the surface to make sure that there are no white streaks or spots that have been missed. If any are found they should be carefully patched with a pouring can.

Having examined the surface and found it o. k., pea stone should at once be uniformly and lightly thrown upon the asphalt while it is still hot, and the surface should be rolled while warm. The application of pea stone should be so light that the roller at all times will be bearing on the number 1 stone and not on a cushion of pea stone. If the wheels of the roller stick to the asphalt, as they probably will in warm weather, they should be oiled. More pea stone should be added as the rolling takes place, until the surface has an even texture with the voids mostly filled, but with no loose or surplus pea stone on the surface.

In spreading the pea stone, care should be taken to keep back about twelve inches from the edge of the spray along the middle of the road, so that there will be less chance of getting a puddle along the joint due to overlapping when the second half of the road is sprayed. Having covered the first application of asphalt with the proper amount of pea stone, and having thoroughly rolled the surface, then the surface should be swept clean of all surplus pea stone and the seal coat applied.

The Seal Coat:—The seal coat should be applied at a rate of not over one-half gallon per square yard. It is even more important than with the penetration work that the asphalt be hot and the nozzles clean, for the distributor is moving about four times as fast while applying the seal coat. Tar paper or building paper should be spread down on the road and covered with sand, at the point where the distributor is to be opened up, and the distributor should start far enough back from the point where it is proposed to begin spraying so that it will have a flying start and be going at the proper speed when the nozzles are opened. After the load has been applied, the asphalt which landed on the paper is wrapped up and thrown to one side, and if the work has been properly executed there will be a straight line joint where the seal coat started, without surplus of asphalt on the portion already sealed.

If the work has been carefully done, the surface will not have a blot or fat spot in it, and I consider a fat spot a defect in the road. These fat spots may be caused by dirty stone, small stone, stone spread too thin, or overlapping either at the center joint or at the beginning or end of a load, all of which can and should be avoided in order to get perfect results. The seal coat is now covered with one-half inch pea stone, using about the same method as outlined above for the penetration course, that is, being careful not to put too much

on at any one time, keeping it free from bunches and keeping the roller going while the seal coat is still hot.

This final covering of pea stone should consist of just a little more than will stick to the road; it should be broomed about uniformly, and thoroughly and carefully rolled, this final rolling being very important, for there is then no danger of breaking up the number 1 stone. A twelve to fifteen ton roller is better than the ten ton roller for this final work. Not a single load of binder should be applied unless there is an inspector or engineer present. After applying both the penetration work and the seal coat, the bituminous material that overlaps on the shoulders should be trimmed off to the line of the edges of the broken stone, in order to get a good clean-looking line along the edges of the road.

I have been speaking, up to the present, of the asphalt penetration, for I believe that the asphalt penetration is, in most places, superior to tar. However, they are both used in bituminous macadam roads, and the same methods for carrying on the work should be used with either material. Asphalt probably has a longer life than tar, and if properly used will require less maintenance. Tars, however, may be used with certain local stones where the travel is not too heavy, or in cold weather, with more success than asphalt, for tar will work its way into smaller voids than asphalt and works down into the road with travel and hot weather, while asphalt works both upward and downward.

Proper Season for Good Penetration

In the Northern States, the season of the year in which the work is done is very important. I do not believe that perfect results can be obtained on work done after the first of October. Work finished previous to August 1st is usually much better than work finished after October 1st. The reason for this is that work done in the early summer gets the benefit of being rolled during the hot weather, and the travel and sun help to bond the stone and the asphalt.

Maintenance Seal Coat

On every bituminous macadam road there probably comes a time when a maintenance seal coat is desirable. On tar roads this time will probably come during the second or third year, and I recommend using an asphalt seal coat, providing the tar surface is in such shape that it will take asphalt. If the asphalt cannot be applied successfully, I would then prefer a tar of the consistency of Tarvia A. However, if the road has been previously treated with cold tar, it is doubtful whether either of the above seals could be applied successfully. In that case probably a cold tar should be used.

The asphalt roads will last for a much longer time without this maintenance seal coat. A well-built asphalt penetration surface should go at least ten years. On one road, where a native asphalt was used, there has been no maintenance seal coat in fifteen years, and in Dracut, Massachusetts, where five different kinds of oil asphalts were used in 1913, the surface is still unsealed except for the seal coat applied when the road was built.

Mileage of Bituminous Macadam

There are on the State Highway system of Massachusetts today approximately as many miles of bituminous macadam as of all the other modern types combined, and the records for the past year in Massachusetts will show that one-half of the mileage built under contract during the year 1926, has been of the penetration type. This type has been used almost exclusively on the more important State Aid roads, as well as on the main State Highway routes, where trucking is not of major importance. The cost per mile for construction has averaged approximately $35,000 for the eighteen feet and twenty feet width, and approximately $40,000 for the twenty-four feet width; whereas the average cost of reinforced cement concrete road has been approximately $65,000 per mile.

Conclusion

In concluding this paper I shall give, first, some statistical data obtained from a piece of experimental bituminous macadam construction built by the State of Massachusetts in 1913, on which I was a resident engineer; and, second, some maintenance cost data on different types of road surfaces. This experimental road was built in Dracut, Massachusetts, between the cities of Lowell and Lawrence, three and one-half miles in length. It was subgraded with from six to twelve inches of gravel, and the wearing surface, two inches thick, was built on top of a four-inch macadam base with a good grade of local stone, part of which resembled a commercial trap.

Six sections, approximately one-half mile each in length, were built of asphalt, using five different kinds of oil asphalt and one native asphalt, making a total of three miles of asphalt macadam. The remainder, about one-quarter of a mile, was penetrated and sealed with tar.

This road has now been under maintenance thirteen years. At no time have I had any part in this maintenance or in keeping of the costs. From the Maintenance Engineer I obtained the information that less than forty-one dollars per mile was spent on the surface of this road last year, and that the average cost per mile per year for the asphalt portion was less than thirty dollars. The tar portion was considerably higher, on account of having been sealed two or more times, but because there was only a quarter mile of it, it does not seem fair to compare it with the asphalt. Among other well-constructed bituminous macadam asphalt roads in

Massachusetts where the surface maintenance costs have been low, the following may be mentioned:

(1) Weston, on the New York Post Road, three miles in length, built in 1912 and 1913, without foundations, where the average cost has run $106 per mile per year.

(2) Concord, on the Mohawk Trail route, built in 1918 and 1919, three and one-half miles in length, where the average cost has run $102 per year for the first piece built in the fall of the year, and $87 per mile per year for the second piece built in the summer.

(3) Lexington, from East Lexington to Lincoln, on a main State Highway route, three and four-tenths miles in length, built in 1918, where the cost has been $55 per mile per year.

(4) Sudbury and Lincoln, two and one-third miles and two miles respectively in length, built in 1916, where costs have run $82 per mile per year and $60 per mile per year.

Summarizing the data of the above roads, we have approximately seventeen miles of bituminous macadam road, all on main routes, carrying 10,000 or more vehicles per day, built for the most part ten to fifteen years ago, which have cost less than $70 per mile per year to maintain. This shows the possibilities of the well-constructed bituminous macadam road, where proper attention has been given to both design and to the details of construction.

Looking further into the maintenance of this type of surface, I have taken all the bituminous macadam asphalt roads in Districts number 4 and number 5 of Massachusetts, which are the districts joining Boston on the north and west, and which are the districts where the modern type of penetration was first developed, and have found the following data: 126 miles of bituminous macadam asphalt road, built from 1912 to 1924, on which the average surface maintenance cost for 1925 was $133 per mile. (22.5 miles tar penetrate average $493.) In these same districts there are forty-three miles of cement concrete roads, built since 1913, on which the average surface maintenance cost during 1925 was $101 per mile per year.

As a check on the above data, I have taken all the Federal Aid roads built in Massachusetts, which means roads built during the last nine years, and have obtained the following figures for surface maintenance during 1925: A total of 169 miles of bituminous macadam roads (both tar and asphalt) averaged $122 per mile, while 114 miles of cement concrete roads averaged $99 per mile. These 114 miles of cement concrete roads, however, may be further divided into two types as follows: Thirty-nine miles of plain cement concrete, built previous to 1921, seventy-five miles of reinforced cement concrete built since 1921.

The surface maintenance cost for 1925 on the plain cement concrete roads averaged $119 per mile, while the average cost on the reinforced cement concrete averaged only $89 per mile. The above figures on the Federal Aid system of Massachusetts would tend to show that the surface maintenance on bituminous macadam roads that have been properly designed and built, would run for the first ten years at least, not much greater than a reinforced cement concrete road, and practically the same as a plain cement concrete road. What the next ten years will show is for the future to determine.

One conclusion which I think can be drawn from the above is that the bituminous macadam road can be classified as a modern pavement; is suitable for modern travel, and in many localities is a worthy competitor to any of the more expensive types, especially when it is considered that an initial cost of approximately $20,000 per mile can be saved in the construction, and the interest on this $20,000 is an important item. In fairness to both types, I believe that the cement concrete road is not justifiable, and in many of these places the bituminous macadam asphalt road can be built and maintained more economically than the concrete, that is when all maintenance costs are considered, as well as interest on the investment.

Business and Employment Conditions

In Bulletin No. 14, on "Business and Employment Conditions," published by the Pierce School of Business Administration, the statement is made that "If you are in business and did not earn at least 10% more this year than last, you did not get your share and this is the time you should study your methods to determine why your profits were below the average. Some of the large organizations increased their profits 20%.

"It is estimated that the labor turnover in the United States this year (1926) has been 125% of the number employed. In some industries it has been very much larger. This means that to maintain an average employment roll of 1000, 1250 additional persons must be engaged. Suppose that the average weekly wage is $20.00 and that it required about one week for the new employee to become proficient so that the first week's wages is an expense. The 1250 new employees during the year represents an actual loss of $25,000. But some turnover is necessary to maintain the efficiency and morale of the force. If this necessary turnover is 25%, we still have a preventable loss of $10,000. If the net profit is 10%, the net return from the first $100,000 of sales is wiped out. A waste of $10,000 which might have been prevented by more care in the selection of employees, better working conditions, more reasonable supervision, greater promotional opportunities, more equitable wages. Think it over and apply this method of calculating to your own business."

IMPORTANCE OF LIME KILN CONTROL TO AMMONIA SODA MANUFACTURE

By Julius Kirchner*

ALTHOUGH lime burning is only an auxiliary process in soda manufacture by the ammonia process, nevertheless it is of importance not because it yields the carbon dioxide and lime necessary for the production but also because the correct design and operation of the lime kiln are of determinative importance in the economy of soda production. The operation of an ammonia-soda factory requires great skill, constant alertness and continuous operating control. These requirements are particularly necessary in lime kiln control so that the course of manufacture be free from fluctuations so that the uniform operating conditions so necessary in this process may be maintained.

Of the two products of the lime burning the carbonic acid is of the greater importance and I shall point out that it is advisable in the interest of obtaining a high grade lime kiln gas, that is, one high in carbonic acid, to make certain concessions as to the quality of the second product, lime. We shall now undertake to investigate and establish the importance of a high grade lime kiln gas. The production of Na_2CO_3 occurs according to the following reactions:

1) $NaCl + NH_3 + CO_2 + H_2O = NaHCO_3 + NH_4Cl$

2) $2NaHCO_3 = Na_2CO_3 + CO_2 + H_2O$

The sale dissolved in the ammoniacal salt solution is acted upon by the carbon dioxide blown in, in such a manner that sodium bicarbonate and ammonium chloride form. The precipitated sodium bicarbonate is decomposed into ordinary carbonate and carbonic acid in the calcining furnace and the latter product is taken back into the process. The ammonium chloride resulting on the precipitation of sodium bicarbonate is decomposed by distillation and the liberated ammonia is used again.

Using equation 1) and calculating from the molar weights we find that 100 pounds of Na_2CO_3 require 83 pounds of CO_2. For the technical product containing 98.8 per cent Na_2CO_3 we can calculate that 100 pounds of soda require 82 pounds of CO_2. But from equation 2) we find that on calcining the sodium bicarbonate for each 100 pounds produced 41.5 pounds of CO_2 are liberated, or 41 pounds from the technical material. The lime kiln, therefore, need supply only half of the carbonic acid required for the conversion.

The absorption of carbonic acid in the precipitation apparatus is not complete as the exit gases even after washing still contain 5-7 per cent of carbonic acid. To make up this loss about 10 per cent more than the theoretically necessary carbonic acid must be supplied to the process. Taking into account the losses occurring in the exit gases, the amount of total carbonic acid which must be carried through the compressor is 90 pounds per 100 pounds of soda. A further loss of carbonic acid is due to the fact that only part of the carbonic acid liberated in the calcination furnace can be covered and this loss must be made good by the lime kiln. Experience shows that of the 90 pounds of carbonic acid required per 100 pounds of soda, 60 per cent must be produced by the lime kiln and the remaining 40 per cent can be recovered from the calcination furnace. The lime kiln must therefore deliver for each 100 pounds of soda 54 pounds of carbonic acid which, recalculated to a volume basis at 20 degrees C. (68 degrees F.) and 740 mm barometric pressure (29 inches approximately), occupy 508 cubic feet. The gas volume corresponding to this quantity of carbonic acid amounts for a gas containing

30 per cent CO_2 (by volume) in furnace gas: $\frac{508 \times 100}{30} = 1693$ cubic feet,

40 per cent CO_2 (by volume) in furnace gas: $\frac{508 \times 100}{40} = 1270$ cubic feet.

The part due to the calcination furnace is 36 pounds of carbonic acid which at 20 degrees C. and 740 mm amounts to 337 cubic feet. Since the calcination furnace under suitable operating conditions can deliver a gas containing 85 per cent CO_2, the volume of gas to be obtained from the calcination furnace is $\frac{337 \times 100}{85} = 400$ cubic feet (approximately).

The total volume of gas to be delivered to the compressors when the kiln gases contain 30 per cent CO_2 by volume is 2093 cubic feet and when they contain 40 per cent CO_2 by volume is 1670 cubic feet. If the volume efficiency of the compressor is 90 per cent, the compressor volumes required per 100 pounds of soda are for kiln gases containing 30 per cent CO_2 by volume $2093 \div 0.90 = 2325$ cubic feet, and for kiln gases containing 40 per cent CO_2 by volume $1670 \div 0.90 = 1855$ cubic feet. Assume, for example, a daily production of 100 tons of soda by the ammonia process; the capacity and power requirements per hour if the precipitating tower has a back pressure of 2.2 atmospheres are for kiln gases containing 30 per cent CO_2 by volume 193,750 cubic feet per hour

*In Chemiker Zeitung, December 22, 1926.

and 342 horse power, while for kiln gases containing 40 per cent CO_2 by volume they are 139,175 cubic feet per hour and 270 horse power. From this the coal consumption for power for the compressor per 100 pounds of soda is, when 30 per cent CO_2 by volume is contained in the kiln gases, 18 pounds, but only 14 pounds when the kiln gases contain 40 per cent CO_2. For a daily production of 100 tons of soda an increase of the CO_2 content of the kiln gases from 30 to 40 per cent corresponds to a daily saving of 4 tons of coal.

A high grade kiln gas is of importance not only for the possibility of saving in compressor operation and coal consumption but also is of importance in the ammonia consumption. The kiln gases and calcination furnace gases are drawn in by the compressor and then forced into the precipitation equipment. The carbonic acid is absorbed, and the waste gases from the precipitation process pass through a washer before being discharged; the washer removes the rest of the ammonia and some carbonic acid by having the gases pass through the brine which enters the process. As the amount of brine entering the apparatus is determined by the current rate of production it is obvious that the washing is the more effective the smaller the volume of gas to be washed.

We shall now determine what content of carbonic acid can be obtained in the kiln gas and what conditions must be met to obtain this high grade gas. Using the same limestone and the same fuel the CO_2 content of the kiln gas will be the higher the smaller the quantity of fuel used, for to this extent the dilution with nitrogen from the air will be smaller. The amount of heat necessary to raise the limestone to the decomposition temperature of 940 degrees C. (1724 degrees F.) and to supply the heat necessary for dissociation is 34355 B.t.u. and the quantity of carbon needed is 5.13 pounds. However, there are radiation losses from the kiln, heat losses due to the sensible heat carried out by the lime and kiln gases so that 7 pounds of carbon are actually necessary. If for the carbon we use coke containing 75 per cent carbon, the coke consumption is 9.5 pounds for 100 pounds of limestone.

The carbonic acid content of a lime kiln gas for a limestone containing 98.8 per cent $CaCO_3$, using coke with 75 per cent C will now be estimated on the assumption, supported by experience, that 9.5 pounds of coke are necessary to burn 100 pounds of limestone or 1 pound of coke can burn 10.5 pounds of rock. On burning 1 pound of coke the following amounts of carbonic acid are liberated in the kiln:

From the limestone	39.55 cubic feet
From the coke	23.55 cubic feet

The total carbonic acid per pound of coke is thus 63.1 cubic feet. To burn 1 pound of carbon we require theoretically 11.5942 pounds of air. From this figure we must subtract the volume of oxygen which is converted to carbonic acid. The nitrogen remaining from the combustion of 1 pound of carbon is 8.9275 pounds with a volume of 119.75 cubic feet, and from 1 pound of coke containing 75 per cent C is 90 cubic feet. The total gas produced by burning 1 pound of coke is thus

$$G = 63 + 90 = 153 \text{ cubic feet}$$

From the relationship of the carbonic acid to the total gas volume, we find the attainable carbonic acid percentage to be $\frac{63 \times 100}{153} = 41.2$ per cent.

If we carry out the same calculation using 12 pounds of coke per 100 pounds of limestone we find the carbonic acid content attainable to be only 37.9 volume per cent. As a matter of fact the carbonic acid content is always 2-3 per cent by volume less than calculated as the combustion occurs with more than the theoretically necessary volume of air.

We thus see that correct heat economy in the lime kiln affects not only the item of fuel cost but is of even greater importance for the percentage composition of the kiln gases. If it happens that the lime is not completely burned, this, too, must be taken into account as the lime kiln in the ammonia-soda process is to be considered primarily as a carbonic acid generator. In a lime kiln operating most efficiently with respect to carbonic acid production, about 5 per cent of the charge remains unburned, but this ultimately is returned to the kiln.

In order to be able to operate with the minimum amount of fuel an intimate mixture of coke and rock is desirable, the air supply should be under control and heat losses must be diminished as far as possible. An intimate mixture of rock and coke can be obtained by feeding in each addition of limestone with its own quota of coke. Both coke and rock should be crushed before use. The coke is used in lumps as large as the fist which gives a satisfactory distribution of the fuel. The rock should be supplied in lumps not larger than a child's head in order to give the fuel as large a surface as possible to act on. A lower limit for the size of the rock lumps is set by the fact that with too small sizes the resistance to the passage of air is too large. To control the air supplied for the combustion a fan is used, and the air is fed in by a central tube and several air openings at the periphery of the kiln.

In order to obtain a high grade gas the furnace should exert pressure, that is to say, deliver an excess of gas. As the amount of lime necessary to decompose the ammonium chloride produced according to equation 1) is less than the amount of limestone necessary to produce the requirements of CO_2 in an ammonia-soda plant, there is an excess of lime left. It is, therefore, advantageous if the soda plant is able to utilize its excess lime in

some auxiliary process, such as caustic soda manufacture.

In order to diminish heat losses the burning zone of the kiln must be maintained at such a height that the combustion gases can transfer their heat content to the stone and arrive at the kiln exit cooled. In a satisfactorily operating kiln the temperature of the exit gases should not exceed 150 degrees C. (300 degrees F.). At the same time the burning zone should be sufficiently above the discharge holes so that the burned lime is discharged from the kiln just hot to the hands by giving up its sensible heat to the entering air. It is a matter of experience to bring the volume of gas drawn off, the air blown in and the lump size into such a relationship that the kiln operates at optimum conditions with respect to both heat economy and the production of a high grade kiln gas.

To keep the zone of combustion at a constant level the kiln must be charged and discharged frequently in small quantities. If the charging and discharging are carried out in large quantities at intervals the burning zone is drawn down and then rises only slowly and is pulled down at the next discharge again. Thus all the advantages are lost which a uniform combustion zone can provide. A still greater disadvantage of occasional discharging lies in the variable carbonic acid content of the kiln gas, for after every discharge the carbonic acid content sings by about 5 per cent (by volume) and then rises only slowly to the maximum value again.

The brine inflow and the speed or capacity of the compressor are adjusted to the prevailing rate of production. If the CO_2 content of the kiln-gas drops and the precipitators receive less carbonic acid, the solution drawn from the apparatus is weaker which in turn requires a change in the brine feed or the conversion will drop. In the latter case we obtain a larger volume to be distilled. Every variation in the distillation rate is reflected in the saturation apparatus. Owing to the closely interlocking operation of the individual units in an ammonia-soda factory, every variation in the operating elements is felt in several places and may interfere with the whole course of operations and result in a loss in material.

Chemical Industries Exposition

At the meeting of the Advisory Committee of the Chemical Industries Exposition, held at the Chemists' Club, 52 E. Forty-first St., New York City, Thursday evening, February 10th, with Dr. Arthur D. Little of Boston presiding, numerous details of the coming Exposition to be held at the Grand Central Palace September 26th to October 1st, inclusive, were planned and discussed at length. Mr. Charles F. Roth, co-manager of the Exposition reported very excellent progress with the Exposition to the Committee and that three floors of the Grand Central Palace had already been reserved.

At the coming Exposition the speakers on the students' course will comprise such men of note in the field of Chemical Industry as Dr. Arthur D. Little, H. E. Howe, Editor "Industrial and Engineering Chemistry," William Haynes, President "Drug and Chemical Markets"; Dr. Charles H. Herty; Arthur Wright, Filtration Engineers, Inc., of New York; S. B. Kanowitz, Raymond Bros. Impact Pulverizer of New York; W. A. McAdams, Massachusetts Institute of Technology; Otto Manius, New York; A. E. Marshall, Corning Glass Works, New York; E. J. Sweetland, United Filters Corp., New York; H. N. Spicer, The Dorr Company, New York. With such speakers and others of equal importance, the Students' course under the guidance of Professor W. T. Read will be of even greater interest than in the past.

Prominent among the features will be the various geographical exhibits divided as follows: The Southern section by States and railroads to show the raw materials and opportunities of the Southern States; The Canadian Section by Provinces and railroads to show the raw materials of Canada suitable for industrial development. The Container Section, exhibiting containers used in industry with the machinery for packaging, bottling, and labeling; and a Laboratory Supply and Equipment Section. The sectional exhibits will be supplemented by displays of chemical products, machinery used in manufacture and development, dyes and fine chemicals, as well as instruments of precision, unit processes developed and in operation.

One of the features, the date for which was decided by the Advisory Committee is the designation of Wednesday evening, September 27th, as the date for the American Chemical Banquet. Notification with complete details will be sent to all societies meeting during the week of the Exposition. Many new features are being planned for this coming Exposition. One of interest is the change in policy which will admit exhibits of foreign manufacture for showing in the Exposition. This change has been made because the American Chemical Industries are now in a position that exhibits of foreign products would prove stimulating and at the same time give American manufacturers an opportunity to see what European manufacturers are doing.

The Exposition regularly draws a large attendance of foreign visitors. They came from twenty-three countries to the last Exposition, and a considerably larger number have already indicated their interest in the coming show. Intending visitors or exhibitors are urged to communicate with the management of the Chemical Industries Exposition, Grand Central Palace, New York, U. S. A., to secure further information about exhibits and exhibit space available, etc.

GRAVEL INSPECTION METHODS IN MICHIGAN

By R. L. Morrison
Director, Michigan State Highway Laboratory*

SOME years ago the general idea seemed to be that all contractors and material men were constantly looking for, and taking advantage of, opportunities to "put something over" on the engineers, and that the main function of the inspector was to act as a spy, or watch-dog, to detect and prevent such attempts. This attitude on the part of the inspector naturally made the party of the second part feel that he might as well "have the game as the name" and each job was apt to be a lively contest between the inspector and the foreman to see which one could tag the other oftenest. As a rule the foreman considered most of the specification provisions as pure "tommyrot" and his ignorance of what was needed was only exceeded by that of the inspector, whose qualifications for his position were too often about 99 per cent political and a small one per cent technical. The gravel inspector usually believed that he must reject a certain number of cars each day in order to hold his job and the particular cars to be rejected were often chosen by the "eenie meenie miney mo" method.

Fortunately those days have passed into history. Today the engineer recognizes the producer as a man whose ethical standards are just as high as his own, the producer's problems are better understood, and a sincere effort is being made to secure the desired results with the least possible interference with production. On the other hand the producer is studying the engineer's problems and is constantly devising methods for the improvement of his products along sound engineering lines.

The function of a laboratory engaged in the inspection of sand and gravel is threefold. First, it should see that the materials supplied to the work comply with the specifications. Second, it should conduct research investigations to aid in determining just what properties the sand and gravel should be required to have for a given purpose, and what customary specification requirements can, or should, be modified, if there are any such. Third, it should assist the engineer with advice in specifying and using the materials under various conditions and it should assist the producer with advice, when requested, as to possible methods of improving the product so that it will comply with the specifications, if difficulties occur.

Before taking up the matter of inspection methods, it may be well to say a word about specifications. The beginner, when he first comes in contact with construction work, in any capacity, is apt to feel that specifications are something almost sacred, the product of an infallible wisdom. It would seem that too often this attitude is never outgrown, for few investigators have had a sufficiently Missourian complex to determine the exact effect of varying different properties beyond the customary specification limits. Unfortunately, when they have attempted to do so, the doctors have not always agreed, as witness the violent controversies as to the proper method of grading concrete aggregates.

Our present specifications are based partly upon sound deductions drawn from long experience, partly upon accurate scientific investigations, and partly upon opinion and tradition. The last named class of provisions is being subjected more and more to the fire of experience and research and it is probable that within a few years specifications for sand and gravel will be based entirely upon known facts. Sometimes the supposedly known fact of today becomes an exploded theory tomorrow, but at least knowledge is crowding out unsupported opinion and tradition, and will continue to do so.

The reasons for the various provisions of our specifications are about as well known to modern producers as they are to engineers, and a detailed discussion of them would take entirely too long. It will suffice to say that while the specifications are admittedly imperfect, they are based upon the best information available at present. Changes will be made as our knowledge increases, and every effort should be made to add to our knowledge, but in the meantime it should be remembered that these specifications have been developed through years of experience, and have given the best results which have been obtained to date.

The organization of the sand and gravel division of the Michigan State Highway Laboratory consists of an aggregate laboratory at Ann Arbor, and a corps of plant inspectors in charge of a chief inspector. When the laboratory is notified that a plant is shipping as much as ten cars daily to a state highway project, an inspector is sent to the plant. Before a new man is sent out as a plant inspector, he is drilled for at least a week in the Ann Arbor Laboratory in the testing of aggregates, and if possible is taken to nearby plants to observe their operation or he may serve for a short time as an assistant inspector under a more experienced man.

When he receives an assignment, the new man, together with his equipment, is taken to the plant by the chief inspector. Upon arrival at the plant the equipment is first checked and set up by the new man, and he is instructed in its use under the

*Presented before the Eleventh Annual Convention of the National Sand and Gravel Association, January 19, 1927.

handicaps of location outside the laboratory. The standard equipment consists of the necessary screens and sieves, 2,000-gram capacity scales, 200 c.c. glass graduates, a supply of sodium hydroxide and bottles of organic matter tests, a trowel, a counter brush, drying pans, large spoons, sample sacks and stationery. A small oil stove is required if there are no facilities at the plant for drying aggregates.

Yesterday afternoon, after this paper was prepared, our chief inspector showed me another thing he wants to include in the equipment, which I think might be of interest to you gentlemen, and that is a tube very similar to a cement sampling tube. It is about an inch and a quarter in diameter at one end and an inch and a half on the other, and it has a tapering handle. His idea was to use it in sampling sand—shove it down and pull it up and get a sample of sand at almost any depth, which would save considerable time. He said it seemed to be very successful in trials he had made.

After the equipment has been arranged, the pit is visited and the chief inspector points out possible sources of trouble, such as excessive overburden not removed, clay pockets in the bank, parts of the bank containing an excess of fine material, old stumps, possible oily shale ledges, or other sources of organic matter. This study of the pit puts the inspector on guard against the particular difficulties which may arise from that quarter. From the pit the inspector is taken to the top of the screening plant. As a rule he can get a bird's-eye view from there of the entire layout of pits, tracks, waste piles, etc., which gives him a clear idea of the general system of operation.

Next the material is followed down through the plant and the screening and washing methods are studied. Such items as possible overloading of screens, insufficient water supply, etc., are noted. Special attention is paid to the arrangements for combining the sizes and loading cars. The attention of the new inspector is called particularly to points where segregation may occur. After this examination of the plant a conference is held with the plant superintendent and suggestions are made as to possible methods of eliminating sources of trouble. For instance, arrangements may be made for additional stripping work to reduce the amount of clay going through the plant, the steam shovel may be moved to another part of the pit, the rate of feeding the screens may be reduced, more water may be used in washing, or washing may be done at additional points, arrangements for combining sizes may be improved, baffle plates or other devices may be installed for reducing segregation in loading cars, and one or more men may be put to hand-picking soft stone from conveyor belts. By such methods the quality of the product can often be greatly improved with very small expense to the producer.

The new inspector is then ready to begin work and he is first taught how to sample cars. This is one of the most difficult operations in the whole field of highway materials inspection, and a carelessly taken sample may not come anywhere near to representing the actual average contents of the car. Incidentally, it seems rather like wasted energy to argue over fine-haired differences in screen sizes until the general methods of sampling and handling materials can be so rigidly specified that reasonably consistent results can be obtained on different samples taken from a single car of gravel at different times.

The method used by our laboratory in sampling cars is to dig "shoulders" on about six or seven of the "waves" formed by the movement of the car in loading. About three of these shoulders are usually dug in the center of the waves and the other four about half way between the center line and the side of the car, half of them being located on each side of the center line. Samples are then taken by digging into each shoulder, and these samples are placed upon a sheet of metal. After thorough mixing, the combined sample is quartered, if necessary, to get a single sample of the proper size. Some additional digging should be done to detect the possible presence of sand cores at some distance below the surface. After learning how to sample the cars properly, the new inspector is given additional instructions in making tests under plant conditions, in making reports, etc. Usually the chief inspector remains at the plant for a day or two until everything is running smoothly, and then he makes frequent visits during the construction season.

The routine inspection consists of doing from day to day more or less of the work which has been outlined above, the exact routine depending upon varying conditions at the different plants. As a result of his tests, the inspector soon becomes sufficiently familiar with the aggregates being produced so that he can make a fairly accurate estimate of the grading by watching the loading of the cars. Whenever it is possible to do so, he samples about a third of the cars, and then tests the samples at such times as the plant is not loading cars for state work. It is evident that the majority of the cars must be passed or rejected on the basis of visual inspection only. This is not complete inspection, so that additional examination, and possible rejection, at the job does not constitute double inspection. This matter will be referred to later.

Once a week the inspector tests a sample each of fine and coarse aggregate and then sends the samples in to the laboratory, together with the results of his tests. Check tests are made there and if there is any appreciable variation in the results the inspector's testing methods are checked up. One of the greatest difficulties with which the

inspector has to contend is the formation of sand cores due to segregation in loading. The fine material often drops immediately to the bottom of the car and remains in place, while the coarse material rolls to the side. As these sand cores are at the bottom, it is difficult to detect them after the car is loaded. Every effort is made to watch for their formation and to eliminate them by correcting improper loading methods, and the installation of anti-segregation devices, but in spite of all efforts they will sometimes "get by" the plant inspector, without being detected.

When the volume of shipments to state highway projects is not sufficient to justify placing an inspector at the plant, the inspection is handled on the job, usually by the project engineer. He is furnished with necessary equipment and also sends occasional samples to the laboratory. It is sometimes necessary for the engineer to reject aggregates on the job which have been passed by the plant inspectors. This practice is sometimes referred to by contractors and aggregate producers as "double inspection" and, in the past, has been strenuously objected to by them. Such objections to so-called "double inspection" are, however, based upon a misunderstanding of the situation.

In the first place, the specifications form a part of the agreement with the contractor and cover the materials at the time that they are placed in the mixer. It would be entirely logical under the contract to have all inspection performed on the job, even right at the mixed skip, all unsatisfactory material being rejected at the last moment only. This, however, would involve a great expense in freight and handling charges on rejected material and frequent annoying delays to the work. To reduce such expense and delays to a minimum, the state places the inspectors at the plants to stop unsatisfactory aggregates at the source. In other words, the inspection is essentially at the job, but a man is put at the plant to keep poor material off the job so far as he is able to do so.

As a matter of fact, there is very little material which has to be rejected on the job after it passes the plant inspector, but it is extremely doubtful if plant inspection of aggregates can ever be made 100 per cent perfect. In the case of such materials as cement and steel, samples can be taken in a specified manner from each car and every sample can be tested, so that when a car is once approved there is no reason for subsequent rejection, except possible deterioration from some cause after shipment.

Unfortunately, however, aggregates are not susceptible to such exact plant inspection methods. As an extreme case, there is one plant which has a capacity of about 200 cars daily. This would be an average of a car every seven minutes during a 23 hour day, if shipments were at a uniform rate, and with a much smaller daily output, the rate of loading may be as fast, or even considerably faster, for a few hours a day. As it takes at least ten minutes to sample a car properly, and about an hour to make a complete test of a sample, it is absurd under such conditions to say that an inspector's card on a car should be considered as a guarantee of quality and that all further inspection should be eliminated. What actually happens is that one inspector watches the car as it is filled, and if it looks all right he signals another inspector, who tacks on the card. Five minutes later the car may be half a mile down the track and thirty minutes later it may be on the main line headed for the job. In some cases, aggregates are loaded and shipped at night, which of course makes plant inspection still more difficult. The above discussion should dispose of the "double inspection" bogey, and demonstrate the necessity of inspection on the job, even where the cars bear plant inspectors' cards.

Most of the research work of the Michigan laboratory consists of carefully planned and rather extensive investigations, but short investigations are sometimes made to assist in arriving at a fair and proper decision upon some special point. As an example of the latter type, a question arose some time ago in connection with routine inspection. We had been permitting a maximum of three per cent of certain conglomerate material. This limit was purely arbitrary, but it was believed to be safe, so far as the work was concerned, and did not cause any rejections at the plants. Suddenly, on a Satusday morning, the steam shovels at one of the plants ran into a bank which contained about twice as much as the allowed percentage of this material, and the work was shut down by the inspector. Another representative of the laboratory drove to the plant from Ann Arbor and obtained a supply of the questionable material. When he returned Saturday night, several members of the staff worked until midnight making up Lumnite cement cylinders, using varying percentages of the conglomerate. The cylinders were broken Monday morning, and as a result of these tests, the limit was raised sufficiently so that loading was resumed immediately, with no rejections made.

An example of more detailed research work was an investigation of the effect of soft stone in concrete. Compression cylinders, beams, and Talbot-Jones wear blocks were made and tested at various ages. As a result of these tests the limit on such material was raised sufficiently to permit the use of one large deposit which would have been rejected entirely under the former ruling, and it might have been necessary to abandon the plant, as the entire output was being furnished to the State. In both of the above cases the investigations resulted in large savings to the producers after the tests had definitely indicated that a modification of the specifications would not do any injury to the work.

The exact effect of other presumably deleterious particles in gravel is being studied, and when the

investigations have been completed the results will be published. When samples of aggregate are submitted by engineers in the field the laboratory does not make positive acceptances or rejections, but always makes a recommendation. The reason for this is that in borderline cases full knowledge of all local conditions is necessary for a proper decision and the laboratory seldom has such detailed information. The recommendation, however, is almost always followed.

Our inspectors are instructed never to interfere with the operation of a plant or to give advice to producers unless they are sure that it is desired, but we are always glad to make suggestions when they are desired, and the majority of the plants in Michigan have made various improvements at the suggestion of the laboratory. I cannot speak too highly of the cooperation which we have received from the gravel producers. They have assisted us in every possible way, and during the two years that the plant inspection of gravel has been in charge of the laboratory, there has not been a single controversy which has not been amicably settled to the satisfaction of all concerned.

Single Company of Builders Buys $10,000,000 in Materials

The extent to which an individual company of engineers and builders purchases pit and quarry materials can be gathered by considering the case of The Austin Company. This company is now purchasing for stock in order to partially meet the 1927 material requirements the following items and quantities:

484,000 Barrels of Portland cement.
96,000 Yards of sand.
149,500 Yards of aggregate (stone, slag and gravel).
30,000,000 Brick.
15,000 Tons of steel shapes, plates and bars.
20,000 Tons of fabricated structural steel for buildings.
20,000,000 Feet, BM, of lumber, consisting of timbers from 16 in. down to dimensions of 2 in. and 1 in. sheathing and miscellaneous lumber.
50,000 Sq. ft. of steel rolling doors.
5,100,000 Sq. ft. of built-up composition roof waterproofing.
2,000,000 Sq. ft. of steel sash.
2,000,000 Sq. ft. of glass.
450,000 Sq. ft. of maple flooring.
100,000 Sq. ft. of wood doors.
75,000 Gallons of paint.
400,000 Sq. ft. of wood block flooring.
3,000 Tons of metal roofing and siding.
1,000 Tons of putty.
12,000 Tons of reinforcing steel.
100,000 Lineal ft. of mechanical sash operating devices.
1,000,000 Sq. ft. of cement tile roofing.
450,000 Sq. ft. of gypsum roofing.
1,000 Tons rivets.
300,000 Sq. ft. of floor hardeners.
50,000 Sq. ft. of fire doors.
500,000 Sq. ft. of wire mesh for floors.

The total value of the materials listed would be approximately $10,000,000. The requirements of The Austin Company can be more readily appreciated when some facts regarding its building operations are known. The number of construction projects under way at any given time are close to 100. The projects include complete plants, costing over a million dollars, as well as small plant units, in the form of extensions and separate buildings.

In a large plan of expansion The Austin Company has established and maintains complete building organizations through branch offices from coast to coast. In Philadelphia there are all the various departments, such as Sales, Construction, Purchasing, Accounting, Engineering and Equipment, and the same facilities are available in Seattle and Los Angeles. The prospective client in the East may make every arrangement in an Eastern office for branch plant or warehouse projects in the West, and the operation will work with equal precision the other way around. Firms like General Electric Company, Henry Disston & Sons, Hubbard & Company, and others, have favored the policy of having West Coast branches, because of the saving of time in making deliveries of finished goods and in saving of freight rates in the shipment of raw and semi-finished materials. The Austin Company maintains trained job crews at each branch organization and has offered these manufacturers local knowledge and country-wide experience and the price-saving advantage of essential building materials in stock.

Austin Company operations are carried on in every industrial section of the United States and Canada. Austin has also built plants in nineteen foreign countries.

Stocks of Coal

The Bureau of Mines, Department of Commerce, has completed a survey of the coal in stock as of January 1st. The survey shows that in the hands of commercial consumers, retail dealers, etc., there were 55,000,000 tons, and in addition 5,567,000 tons on the docks at the heads of the Great Lakes; there is also a rather more than normal amount of coal in transit. In comparison with a year ago present stocks show an increase of 6,000,000 tons.

The actual consumption of coal as distinguished from production for the last quarter of 1925 averaged 11,200,000 tons a week. Production is now averaging about 13,400,000 indicating a further advance of stocks.

CONSTRUCTING A GRAVEL WASHING PLANT FOR TRUCK SERVICE

By F. W. Cornuelle
Red Bank Gravel Company*

FROM a number of years of experience in the gravel business in Cincinnati and the immediate vicinity, both in the building of plants for either rail or truck service, I find the construction of a trucking plant should be somewhat different than a plant built for car load shipments.

In the building of a gravel plant for truck service, there are several very important items in construction to consider that are of major importance for the successful operation of such a plant. Large bins or storage capacity for a truck service plant is of vital importance, and moneys expended for this purpose will lend more to a successful operating plant than any other one item. Deliveries made from a plant of this nature, and the requirements for sand and gravel called for at the plant are irregular, especially so when sales are to retail and wholesale customers, and such a plant must of necessty be built to serve a flexible demand.

In our own operations we have experienced a variable requirement which mounts from a couple hundred tons one day to over a thousand the following day, causing us quite a bit of anxiety in the maintenance of service. With sufficient storage tipples, requirements of this nature are more easily met. The building of two similar plants with duplicate machinery for each plant has proved to be a very successful method of combating such problems. There is, however, a saving in labor in the building of the larger unit over the operating expense of two plants. A plant built with ample storage affords the operator a chance to serve the trade on the peak load days. He may also find time to make a few minor repairs, that may arise, provided the plant is backed up with large storage and still maintain his regular service.

The sale of sand and gravel in many instances is a one-day transaction, and the plant with a small bin capacity on such days as the demands are greater than their operating ability, must either refuse business so offered, or run short of material some time during that particular day. This act today in the minds of the contractor constitutes an unpardonable sin, and ultimately causes a loss of trade. The building of a washing plant with ample storage capacity enables the plant owner to operate on such days when the demand for gravel is below normal, and also allows for an even distribution of the employees. A plant so designed can operate without interruption on the bad days, when the weather would not permit laborers working out in the open. The yard and track work can then be done when the weather will permit, provided, of course, there is sufficient storage of sand and gravel in the hoppers.

We have found from past experience that for one and possibly two days in each week, we will have a sale for sand and gravel greater than the rated operating capacity of our machinery. With a bin capacity large enough we are able to care for such requirement, and are in position to sell our operating output plus whatever bin capacity we may have. In other words large storage is the solution to a more uniform delivery and operation. The question may now arise as to what constitutes the correct size of a trucking plant. My answer would be that a truck service plant should be so designed that the operating capacity should be equal to what may be the peak day demand, and the storage capacity should be equivalent to double the operating capacity.

The water content in sand and gravel when delivered direct from a washing plant is the cause of much complaint and criticism from the consignee. Water dripping from trucks delivering sand and gravel often times leaves the roads leading from a washing plant wet and sometimes unsightly. In some localities laws have been enacted prohibiting the carrying of sand in a wet condition. Sand and gravel delivered on the job wet, causes the contractor quite a bit of inconvenience on account of the condition of the yard storage space. Wherever such material is dumped there is always a loss when same is to be reclaimed.

The brick and plaster contractors prefer sand delivered in a semi-dry state, so that they can mix the lime or patent mortar with the sand dry before adding water. A number of the mason contractors will not receive wet sand at all. Making an allowance for water content for materials delivered in a wet condition is only fairly satisfactory. In the first place the consignee is more or less skeptical and rarely ever does he believe that a certain percentage has been deducted from his invoice for water. In the second place, if the shipper does deduct for water, he is forced to haul a tonnage for which he receives no pay. This will amount to several thousand dollars in a year of fairly good tonnage. There are today several de-watering apparatuses on the market, but none as yet will take wet sand direct from a washer and reduce the

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water content so that it is entirely satisfactory to the trade.

Although we have used a de-watering machine for several years, we find the best solution for draining sand is in the use of duplicate bins for the same class of material. By this method we are able to serve sand and gravel from bins where the material has been stored at least twelve hours and sometimes a day before it becomes necessary to draw it out. This allows the water to drain out, and saves the expense of making a large water allowance. While on the subject of water, I might add that the source of water supply is very important when washing gravel in freezing weather. Water taken from a river or small stream when the outside temperature is freezing or below, will be near the freezing point, whereas water taken from a cased-in well will register no less than 50° Fahrenheit. Sand and gravel washed with water at this degree of temperature, will pass into the bins at a much higher temperature than gravel washed with river water. Gravel so washed will retain a temperature above freezing in the bins for quite a long time, depending upon the size of the bins, and can be delivered free from frost.

The width of the runs under the tipples of a trucking plant is entitled to some consideration. A runway built too narrow will cause the trucks to bump the sides of the walls and a loss of time in loading; on the other hand where a driveway is wider than necessary the drivers are inclined to become careless in spotting their trucks for loading, with the result that the equipment is very often loaded to one side. We have found that a driveway about 9½ feet in width answers the purpose very well. Batch deliveries of sand and gravel today necessitates the building of tipples with more headroom. Although the average truck, including the cab, is not much over eight feet high, it is necessary to build the floor of the tipple about fourteen feet high to permit the use of batchers.

Washing plants can either be built of wood, concrete, or steel, and although concrete is preferable for permanent construction, a bin so designed will hold water longer than a wooden structure and will not drain as readily. Where wood is used the floor of the bins and the side walls for the runways and support of the tipple should be concrete. If this is done the runways at either end can be housed in, and the bin gates kept from freezing for winter operation by the use of salamanders.

The type of wooden bin construction commonly used is built by standing a certain size of studding upright, nailing the sheathing to the inside, and girdles belted around the outside, and tied together with rods running through to either side of the tipple. This makes a very rigid tipple, but on account of the horizontal position of the sheathing boards, and the numerous angles for water it will rot in a short time, and it is also difficult to repair.

The silo type of wood construction, although it is a somewhat more difficult task to build, makes a more permanent tipple. It will not rot nearly so quickly, takes less lumber in building, and saves several square feet of floor space of the outer area of the building. A tipple should be built square or nearly so wherever it is possible, and is preferable to the oblong type of construction. There is a saving in the amount of material used, it allows for more than one runway under the tipples, and also provides better floor space on the top floors to place the machinery.

The machinery in any washing plant should be simple, with as few chutes as possible to do the work required. Ample floor space around each screen is very necessary. Cramped placing of machinery is often times the cause of insufficient oiling. It also retards making repairs when screens are placed too close to each other. Where electric power is available, an individual motor for each unit is advisable. The motor should be larger than the rated horse power of the machine to be driven, to insure steady power with few breakdowns. In a plant we just recently completed we installed a separate motor for each machine. The motors operate through a speed reducer. Thus we are able to eliminate all belt, spur-gears and chain drives. The speed reducers were placed on trial and proved to be a success.

On account of the oversize gravel in many deposits the installation of crushers is essential. There is a difference of opinion as to the location of the crushers relative to the balance of the screening machinery. In some plants the crushers are placed up in the building while in others they are placed on the ground level. When placed in the plant so that the oversize may be fed direct to the crusher from the grizzly screen, there is a saving in reelevating the crushed produce, but the stone is generally wet and more difficult to screen. The crushers take up valuable space in the plant, and it is impossible to provide storage space for the uncrushed oversize in case of breakdown to the crushers. Placing crushers on the ground floor allows room for the uncrushed oversize.

Magic in Our Buying Power

In discussing this subject, George E. Putnam, in the December issue of American Bankers Association Journal, states: "Some of the increase in consumer buying power is the direct result of our increased production per man. Through the adoption of mass production methods and improved processes we have made phenomenal progress in lowering unit costs and in increasing labor efficiency. The wage earner, no less than society at large, has been the beneficiary of these economics, to buy more goods with his weekly pay check. This is only another way of saying that increased production per man makes for higher real wages and greater purchasing power."

CRUSHED STONE IN INTERMEDIATE TYPE OF ROAD CONSTRUCTION

By C. N. Connor
Chairman, Low Cost Improved Road Investigation, Highway Research Board*

IN THE PAST much of the progress on low cost improved roads has been the direct result of necessity rather than of correlated effort, design and controlled experimentation. Within the last few years motor transportation has increased by leaps and bounds and traffic surveys have shown a steep upward trend in registration, with no indication that the saturation point has been reached, or that the curve will break downward. Engineers and others are now realizing that this traffic must be served and that it is sound economy to give road service at once. They are therefore cooperating with industry to solve this problem of general road service. The problem has been and can be met in many instances by comparatively low cost improvement of existing roads and by the intelligent use of local materials combined with shipped in binders and admixtures.

The intermediate type road for the purpose of this discussion may be considered as a surface lower in type, cost and traffic capacity than portland cement concrete and concrete base with asphaltic top, but higher than untreated sand clays and gravels. In order to fully realize the magnitude of the possibilities in intermediate or low cost road construction, let us consider for a moment the road mileage of the United States in the light of the last published figures. Those given by Mr. Thomas MacDonald in 1926,—the total mileage of the country was in 1924 about 3,000,000 and the total surfaced mileage including types as low as sand clay was about 468,000, leaving as a difference of unsurfaced roads something over 2,500,000 miles. Let us leave this 2,500,000 miles for the minute and investigate by analysis the 468,000 surfaced miles; we find approximately 308,000 miles are surfaced with nothing better than untreated sand clay and gravel; 105,000 with water bound macadam, surface treated macadams and gravel, and bituminous macadam; leaving only 55,000 miles of the higher and miscellaneous types.

Analyzing Mr. MacDonald's figures still further, in order to determine the road mileage which may be improved from the low or partially inadequate surfaces to the intermediate type, we find sand clays 63,681 miles, untreated gravel 244,282 miles and water bound macadam 60,234 miles, making a total of 368,197 miles or nearly 80 per cent of the total surfaced mileage in the country. We have therefore 368,000 miles of highways a large portion of which, in its present condition, is suitable for only 500 to 700 vehicles per day. The use of local materials has properly played a large part in the construction of practically all of these low type surfaces.

The reasons for improving this large mileage, are, of course, to increase traffic capacity, to make them serviceable at all seasons of the year, to furnish smoother riding surfaces, to prevent loss of surfacing material, to reduce the dust nuisance and to increase their safety. More and more we are realizing the value of progressive or stage construction, which means building upon a suitable subgrade, a subbase and surface which will carry traffic for a time at least and which will later be very valuable as a base course for an added, new surfacing of more substantial materials. It is this surface or top course which particularly opens a wide field for the use of crushed stone.

Subgrades

In the study of non-rigid surfaces in which crushed stone is an important material, we must consider the subgrade and subbase or foundation course, for to overlook the importance of the subgrade in building any type of road construction would be similar to neglecting the investigation of a bridge foundation before designing the structure. I will not, however, burden you with a discussion of subgrades and soils about which so much has been written and about which so little is known—but will only say that soil studies in connection with bearing capacities of subgrades are being made by the Bureau of Public Roads and the National Research Council. Until we receive definite information from these or other authoritative sources, we must continue, as in the past, to study the local soil and climatic conditions and be guided by what our expensive teacher, experience, has taught.

Subbase

This brings us to the subbase or foundation which in present practice is nothing more or less than a layer of porous or semi-porous material placed on the subgrade to assist in distributing the load to the subgrade, to absorb part of the impact from traffic and to improve the drainage conditions beneath the base course. For example, experience has proven to the New England road builders, that under their climatic and traffic conditions practically all subgrades must be improved by a subbase or foundation course of gravel or

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stone. On the other hand it is probable that in portions of the southern states, in dry and arid regions and in sandy locations the subbase or foundation may safely be omitted.

Base Course

Were it not for the fact that due to the lack of funds, and other causes, all types of road construction have been unable to keep pace with traffic demands, we could build progressive type or stage field, however, is still large in which the surface construction in places which now can be satisfied with only the highest types of construction. The course of today may be used as the base course for a number of years to come. In this class are the thousands of miles of sand clay, chert, shale, gravel, soft and hard stone macadams which have been built and compacted by traffic or rolling. In the more sparsely populated sections hundreds of miles of these types are still being constructed annually.

Their service, however, is limited to a daily traffic of from 500 to 800 vehicles unless the public will accept dust and a rough riding surface caused by pot holes and corrugations. It is this class of road which opens up a wide field for improvement with surface treatments and intermediate types of surfacing. Many, indeed, are the methods which have been tried, but in and throughout, we find credit given to the desirable results obtained where crushed stone is used as an aggregate. While it is not probable that this convention is particularly interested in all the details of surfacing, you are concerned with those which include crushed stone.

Surfacing

The types in which crushed stone with bitumen are being successfully used are more easily described than named; however, to identify them I will call them by the names which are in fairly common usage; they are:

1. Skin surface treatments, less than one inch in thickness.
2. Mixed in place surface, generally one to two inches in thickness.
3. Bituminous macadam, two to three and one-half inches in thickness.
4. Bituminous concrete, black base and sheet asphalt.

Your will note that all of these surfaces require the use of bitumen as a binder and that the thickness of the surfacing, except black base, is less than is considered good practice in portland cement concrete surfaces. This is because they are wearing and protecting surfaces which after absorbing a portion of the impact transmit the wheel loads to the base course; the base course in turn carries the load at a reduced intensity on to the subgrades. Whereas a portland cement concrete surface must, in one course absorb both the wear and the impact. These surfacings have been used on many types and thicknesses of base course, but it must always be borne in mind that the most successful are those which are laid on well compacted bases composed of good sand clay or top soil, lime rock, gravel or stone. This base course must also be stable and capable of resisting lateral displacement, before the investment of funds in a top course is warranted.

Skin Surface Treatment

In this class of treatments bitumen, often a light tar, is applied as a prime coat on the prepared surface of the existing road. This prime treatment acts very much as a prime coat of paint on unpainted wood or steel. It penetrates the base, partially binds together the particles penetrated, creates a condition of greater stability of base surface and assists in binding subsequent treatments to the base course. This prime coat is frequently left uncovered until the second application of bitumen.

When the second application of bitumen has been applied, it is immediately covered with coarse sand, pea gravel or stone chips. Frequently engineers prefer hard stone chips on account of their wearing quality and the keying and binding effect of their irregular surfaces; stone chips are particularly desirable for surface treating macadams. For the first year on an eighteen foot width this treatment will cost per mile from about $900 to $1500. Subsequent treatments will cost somewhat less depending on traffic and climatic conditions. The traffic capacities of these surfaces on good sand clap and gravel bases without excessive maintenance will range from 800 to 1500 automobiles and light trucks per day. Surface-treated stone bases and macadams will usually carry a much heavier traffic than the treated bases of sand clay and gravel.

Mixed in Place Surfaces

Within the past two or three years the mixed in place surfacing of stone and bitumen has been receiving considerable attention in locations where a new wearing surface is required to prevent destruction of the existing surface as well as to improve its riding qualities, at a reasonable yearly cost. It has been used successfully for the purpose intended in several states on bases of top soil or sand clay, chert, shale, gravel and crushed stone. In order to give you first hand information, I will quote from the statements of some of the highway officials who have tried out this type of surfacing. After considerable experimental work on surfacing top soils in South Carolina, Mr. Moorefield, the State Highway Engineer, makes the following statement:

"The best results we have obtained, however, have been with a double surface treatment using tar suitable for cold application as a prime coat

and asphaltic oil as a cover coat with crushed stone as the stabilizer. This method of treatment has produced a satisfactory road surface for traffic up to 1500 vehicles per day where the original road surfacing consisted of firm material with a relatively large content of gravel or sand and only sufficient clay to serve as a binder and where the road is well drained. The method of treatment which we have followed in such cases to the extent of about 120 miles, is briefly as follows:

"1. Scarify the old road surface; add new surfacing material as needed; road machine to standard cross section; then maintain carefully under traffic until the road surface is smooth and well bonded.

"2. Then, while dry and before waves have had a chance to develop, sweep all loose material from the road surface and apply from one-quarter to one-third gallon per square yard of tar suitable for cold application, viscosity eight to thirteen at 40° C.

"3. After the tar, which is applied as a priming coat, has had twenty-four hours to penetrate, heated asphalt of 150-200 penetration is applied at a rate of one-third gallon per square yard.

"4. The asphalt coat is immediately covered with about 50 pounds of crushed stone, graded inch and one-quarter to one-quarter inch per square yard, and rolled thoroughly with a five to six ton roller.

"5. The road is then opened to traffic. The surface under a few months exposure gradually changes its appearance from a plain crushed stone surface to a bituminous surface with many exposed stones.

"6. The surface is then given a seal coat of a rather light asphaltic oil, applied hot (oil containing about sixty per cent of 100 penetration asphalt), at a rate of about one-fifth gallon per square yard. This coat being covered with from fifteen to twenty pounds of coarse sand per square yard to prevent picking up under traffic.

"The original cost of this treatment is around $2000 per mile for a treated width of twenty feet. This cost does not include interest or depreciation on the equipment used nor cost of engineering supervision. Roads treated in this manner are carrying 1500 vehicles per day in a very satisfactory manner. Maintenance costs are about $400 per mile for the first year and about $300 per mile per year for the second and third years. Beyond the third year we are not yet able to forecast what will be required. On one short stretch treated in this way where the traffic was well above 2000 per day a retreatment was necessary after about eighteen months. When the retreatment was made the old bituminous material was scarified down into the earth surfacing material, and it appears that additional stability for the roadbed was secured in this way. Before applying the retreatment, however, gravel was added to the original surfacing so that the results of mixing the bituminous material with the earth material will not be evident in the life of the new treatment. In this case the condition of the roadbed was greatly improved between the two treatments and the last one has now served for some six months without the least sign of failure under increasing traffic. We feel assured that when our original treatments break up or otherwise fail, the roads can be scarified, reshaped and retreated with the expectation of securing at least as good results for the second treatment as for the first."

Tennessee, where the commission was faced with the problem of carrying traffic on its rapidly failing gravel, macadam and chert roads, made a study of what other states had done under similar conditions and finally decided on the following method as expressed by Mr. Bass, Commissioner:

"The success of the finished road depends very largely on the preparatory work. Where sufficient material is not already on the road, new material is added in order to bring the minimum thickness up to at least four inches. The regular maintenance of blading and dragging is kept up until the tar is applied, care being used to establish the desired cross section, obtain proper drainage, and secure standard super-elevation on curves. The surface is then thoroughly broomed with a power broom, removing all loose material. The prime, consisting of four-tenths gallon of tar with specific viscosity between thirteen and eighteen (Pennsylvania specifications) is then applied. The cover material for the first application varies from nothing to twenty pounds per square yard. The road is kept open to traffic and during the four to fifteen day interval, usually between the first and second applications, the weak spots develop and pot out.

"The second application, consisting of from three to five-tenths gallon of tar, specific viscosity between eighteen and twenty-seven, is then applied cold, and from 50 to 80 pounds of cover material between an inch and one-quarter and five-eighths inch is then spread uniformly. This is bladed and dragged for two or three days, until the volatile matter is out and the mixture too stiff to manipulate with the drags, after which a five-ton roller is used continuously until the surface is well set up. After a few days the surface becomes well cured and presents a very pleasing appearnce.

"The high points in the process are the patching of the pot holes following the first application, and the dragging and rolling while the second application is setting up. It is often necessary to spread a light layer of cover material in advance of each application on steep grades in order to retain the bituminous material. The cost of this treatment varies from $1100 to $2200 per mile, and roads of remarkable smoothness are obtained. We have treated approximately three hundred miles, most

of it this year, and it is difficult not to be too enthusiastic over the results."

In West Virginia, Mr. Gray, Division Engineer, is also quite enthusiastic over this method of construction. Mr. Gray says:

"It is first necessary to thoroughly consolidate the roadbed by frequent dragging and blading of the surface so as to obtain a smooth cross-section and profile. The crown should not exceed three-eighths inch per foot. It is desirable further that this surface be treated with light asphalt or tar so as to make a prime coat.

"On the roadway thus prepared, a layer of stone approximately two inches thick is spread and penetrated with light cold tar at the rate of about five-tenths gallon per square yard. Traffic is allowed to use the road continuously and for several days there is a whipping about of the stone fragments. At the end of about the fourth day the stone begins to have a "tacky" consistency, at which time a grader should be run over the road in just the same manner as though an earth road were being bladed, so as to shape the stone to a smooth cross-section and profile. If convenient, although not necessary, a light roller (such as a five ton gasoline roller) can be run over the road immediately after the grader which will come down under traffic in a surprisingly smooth and satisfactory manner and with a minimum amount of patching will present an excellent riding surface for the remainder of the season. During the winter when the frost is coming out of the ground, there may be some heaving and breaking through of the thin surface, but in general, on all except very clayey soils a fairly traversable surface will be had all during the year.

The following spring as soon as the ground has well dried out, this surface should be scarified for the depth of the stone and then bladed to each side in two windrows. Between these windrows a new two inch layer of stone is spread and penetrated as before. The two windrows are then bladed back on this new layer and the same process of grading repeated as in the first year. The resulting surface will, of course, be much better this second year and with much reduced breaking up during the winter season. Repeating this process for three or four years will finally result in a solid, substantial pavement. The method of course is only applicable to fairly stable soils and where traffic made up of light units is found.

I feel that this method is one that will come into great use as soon as it has been tried in any locality. It affords a method of quickly improving long mileages at a low cost because of the cumulative value of the stone added each year. For sixteen foot width roadway the annual cost would be about $2,000 to $3,000 per mile and at the end of the fourth year a good macadam surface will have been built up, which can be thereafter maintained as any other macadam surface by patching and surface treatment."

Pennsylvania was probably the first state to develop this method of surfacing which Mr. Van Duzer, Deputy Engineering Executive, covers in the following departmental specification—

Pennsylvania Specifications

The surface course shall consist of a two inch, after final compression, one course rolled surface composed of three-quarter inch stone, known as P.H.D. No. 2, constructed upon the prepared base course in accordance with these specifications, using stones that will pass over a screen having a circular opening of five-eighths inch and through a screen having an opening of one and one-quarter inch. The prepared base course shall be cleaned of all foreign substances and the stone shall be spread upon it with forks from piles along the sides of the roadway, or from dumping boards, or may be spread directly from approved vehicles constructed for this purpose. The stone shall be rolled with a three wheel power roller, weighing not less than ten tons, until it is compacted to a uniform, even surface. The rolling shall begin at the sides, overlapping the shoulders for a distance of not less than six inches, and progress to the center parallel with the center line of the roadway, uniformly lapping each proceding track and covering the entire surface with the rear wheels.

Bituminous Material

After having been rolled satisfactorily, the bituminius material (which shall conform to the limits of Class "D" bituminous material) shall be applied in two applications, total bitumen ranging from 0.5 to 0.75 gallons per square yard, after which the surface shall be rolled with a ten ton roller to a uniform cross section and allowed to dry from twenty-four to thirty-six hours. The second application of bituminous material shall be made at the rate of 0.2 to 0.35 gallons per square yard, depending upon the appearance of the first application. Where a dull brown color exists, it will be necessary to apply a larger amount of bituminous material than where bitumen shown on the surface from the previous application. After the last application, the rolling shall continue until the surface is thoroughly compacted."

I have gone into the mixed in place surfacing in some detail, as it promises to become a reasonably good method of improving, with crushed stone, many miles of what are now inferior road surfaces, and at a moderate cost.

Bituminous Macadam

Bituminous macadam is very familiar to all of you but we cannot well afford to overlook the excellent service it is rendering particularly in New England. This service in New England is largely

due to the excellent and painstaking care with which it has been constructed and also upon the fact that heavy foundations or subbase are required in so many instances on account of the heavy frost action. Perhaps it is not advisable to construct bituminous macadams with stone aggregate on anything but stone base in sections of the country affected by heavy rainfall and deep frosts, but many of our southern states and some of the western have tried out bituminous penetration stone surfaces on sand clay, top soil gravel and even earth.

One method is to select a well drained, well compacted road of sand clay, top soil or clay gravel which is failing through abrasion by traffic. The surface is just lightly scarified or loosened and then covered with a single layer of stone ranging in size from 3½ or 3 inches to 2 or 2½ inches. The spread stone is shaped, rolled and penetrated with bitumen, after which intermediate stone or chips are spread and rolled. The resulting surface offers resistance to the abrasive action of traffic and is keyed to the old surface by the lower portions of the projecting three inch stone. This type of surfacing is well adapted to light traffic, rural highways, parkways and residential streets. I know of a trial section of this type which is carrying 1,400 vehicles per day at a normal maintenance cost.

In Georgia they are using a standard penetration macadam without a seal coat on a gravel base and in place of the seal coat a course of standard sheet asphalt from ¾ to 1 inch in thickness is used.

Bituminous Concrete

Bituminous concrete of the coarse aggregate type using crushed stone will become more securely keyed to surfaces which are composed of fine materials such as sand clays and some clay gravels than bituminous concrete of the fine aggregate type. Among the patented pavements, Amiesite with its high percentage of coarse stone will tend to become well keyed to such bases. Black base or sheet asphalt with a binder course are well adapted as surfaces on these leaner bases because of the stabilizing effect of their high percentage of stone and its keying effect on the surface of the base course. I believe that a layer over the base course of bituminous penetrated stone, black base, or binder course will materially improve any bituminous surfacing. This was demonstrated on a test section near Raleigh, North Carolina, which was laid under Mr. Upham's direction some three years ago.

The test piece of road was an old top soil surface which was covered with adjacent sections of sheet asphalt, coarse aggregate type bituminous concrete, fine aggregate type bituminous concrete, and penetration macadam. The sheet asphalt section showed the least displacement and destruction under traffic. All of the sections are still carrying traffic of about 1,400 vehicles per day at a moderate maintenance cost. The most marked evidence of fatigue is along the outer edges in each type.

I have had but little to say on the subject of theoretical and practical design of intermediate type roads. The subject has been rather sadly neglected by most engineers but I believe you will agree that we need some theoretical designing of stone surfaces and some test roads with stone aggregate surfaces from which definite conclusions can be drawn and which will develop this type of construction. As possibilities along this line are the thickened edge sections, the wider base than top, and the various sections suggested by Mr. A. T. Goldbeck. Why should not the intermediate types of surfacing be designed and thoroughly tested as well as the higher types? I leave this to you as representatives of an industry which is vitally interested. May I summarize briefly?

There is a need for the construction of a low type surfacing on a tremendous mileage of unsurfaced roads in order to develop isolated sections and furnish feeders to the trunk highways. There is immediate need of surface improvement on a large mileage of existing low type surfacing whose present traffic capacity is probably not over 700 vehicles per day. The intermediate type road is a step in stage or progressive road construction. The first stage after grading is to give road service on a base course of good, local, short haul material. These materials may be sand, clay, gravel, lime rock, shale, caliche, waste industrial products or whatever the locality can furnish cheaply. In this class we find an immense mileage of existing roads whose traffic capacity is limited, as stated before to 600 or 700 vehicles per day.

The cost of these bases or surfaces is generally well known by the local engineers, and will vary with local conditions from $3,000 or less to possibly $10,000 per mile. The next state is the surfacing of the existing base with a better surface. This can be done by utilizing various materials. Probably the best are those which include crushed stone as an aggregate, they are:

Skin surface treatments.
Mixed in place surfaces.
Bituminous macadam.
Bituminous concrete, black base and sheet asphalt binder.

The traffic capacities for these surfaces will range from approximately 1,500 to 7,000 and possibly more vehicles per day. The first cost will range from about $2,000 to $15,000 per mile for an eighteen foot width. The yearly maintenance cost of such surfaces will range from about $1,200 to $2,000 per mile per year. Those having a higher first cost are usually lower in maintenance cost when serving within their traffic capacities.

PIT AND QUARRY FOREIGN DIGEST

Characteristics of Burned Magnesite

Artificial magnesite absorbs three times as much moisture, when stored in air as natural magnesite. MgO may absorb moisture without changing at once into the hydroxide. To determine the setting power of magnesite the hygroscopic moisture, the water of hydration and the carbon dioxide content are determined. $Mg(OH)_2$ is calculated from the water of hydration. With the assumption that the calcium not combined as gypsum is calcium carbonate, the $MgCO_3$ content is calculated from the residual CO_2. The active MgO can be found by subtracting the corresponding Mg from the $Mg(OH)_2$ and $MgCO_3$ from the total Mg and calculating the balance as MgO. A. Stettbacher (Chem. Ztg. Vol. 50, 141-142. 771-74. 1926).

Preheating Fluid Slip

The waste gases from the kiln are led through vessels surrounding the pipes conducting the liquid slip and some heat exchange is effected. G. Polysius (German Patent 435,792).

Cement Burning

Finely ground fuel is mixed with the raw cement mass and burned in sufficient oxygen supply to ensure the complete combustion of the fuel. H. Kuhl (Austrian Patent 104,148).

Aluminous Cement

Pieces of a pressed mixture of finely powdered Bauxite and lime are heated to their softening point, as for example, six to eight hours at 1,100-1,200 degrees and then ground. The product exhibits the same setting and hardening qualities and greater breaking strength than the fused cement made from the same raw materials. U. B. Voisin (Swiss Patent 116,309).

Building Materials

Fibrous vegetable material, such as broken straw, wood, etc., is first treated with a special agent such as magnesium salts or water glass without heat, and then mixed with a material such as Portland cement, gypsum, etc., which sets under the influence of the moisture contained in the fibres. The mixture is poured into molds and after a time removed and allowed to harden completely. Soc. An. Cimenti (Swiss Patent 115,884).

Light Forms of Concrete

Fibrous organic material such as saw dust, is impregnated with a solution containing chromic acid or a dichromate with or without the addition of an acid or metallic salt, that is, a solution containing approximately 2½% by weight each of potassium dichromate and ferric chloride, in order to prevent the swelling of the material with moisture, and is molded under pressure with cement and a filler consisting of powdered limestone or slate dust, in order to obtain a light form of concrete. C. D. Burney & H. O. Weller (British Patent 258,-665).

Sand Washing Machines

The sand (or gravel) is conveyed through a rotary drum, supplied with washing water, by a series of short plates normal to the drum wall and arranged along multiple-screw threads in rows parallel to the axis of the drum. Each plate is so inclined that the whole is engaged in lifting the sand out of the water. The ends of each plate are bent in opposite directions parallel to the axis, and are secured by brackets to the drum wall. Brun et Cie. (British Patent 250,554).

Cement Mixed With Gypsum

Finely ground raw gypsum is added to cement or cooled clinkers and ground together in a mill kept sufficiently cool to prevent the rise of temperature and conversion of the gypsum into Plaster of Paris. G. Pontoppidan and S. Buntzen (British Patent 260, 447).

Transformation of Cristobalite

The raising of the transformation temperatures of natural cristobalite by the action of sulphuric acid above 100 degrees C. is attributed to the solvent action of the acid for impurities which tend to lower the transformation temperature. It does not occur with artificial cristobalites having high transformation temperatures. Hydrochloric acid and nitric acid have no effect. The transformation temperatures of the cristobalite of quartz and of transparent commercial silica are 230-260 and 175-210 degrees, respectively, owing to the effect of impurities while the vapor produced by heating the salts of the alkali metals in a flame may lower the transformation temperatures of cristobalites about 20 degrees, if these are originally high.—R. Weil (Compt. rend. Vol. 183, p. 753-755, 1926).

Hydraulic Cement

In the manufacture of hydraulic cement by melting a charge of basic material such as lime an acidic component such as Al_2O_3, Fe_2O_3, SiO_2 or Ti, oxidizing conditions are maintained in the furnace to prevent reduction of the iron compounds to the metallic or ferrous states. A rotary kiln may be used and bauxite and limestone may be used as raw materials. H. S. Spackman (British Patent 244,756).

Effect of Water Soluble Alkali Salts On the Mixing of Cement

The K_2O content of various cements was found to vary between 0.2 and 1.81 per cent. The Na_2O varied from 0.02 to 0.84 per cent. Shaft furnace cements contain greater quantities of soluble alkalis than rotary kiln cements. When it is recalled that Grimm found an addition of only 0.25 per cent K_2O, Al_2O_3 to normal cement made enormous differences in setting properties, the importance of these figures will be realized. The sulphide sulphur content varied from 0.13 to 0.27 per cent and the author believes that the alkalies are present as alkali sulphides. Addition of K_2S to pure cements gave tests which tended to confirm this opinion. Fr. Killig (Zement Vol. 16. p. 1-3. Jan. 6, 1927.)

Calcium Chloride and Cement

The effect of addition of pure gypsum on the strength of cement after various intervals, was compared with precipitated gypsum and natural gypsum or anhydrite. Pure gypsum had least weakening effect after ninety days, although the impure varities caused more rapid setting. These results were compared with the same cement-gypsum mixtures but with small amounts of $CaCl_2$ added in addition. It was found that after ninety days, the addition of about 0.1 per cent of $CaCl_2$ caused an enhanced value for the crushing strength of all three mixtures with the cement-pure gypsum —$CaCl_2$ mixture having slightly greater strength than the other two. Addition of about 1 per cent gypsum gave slightly lower strength figures after ninety days, but caused an enormous increase in the rapidity of hardening. The effect caused by the addition of only 0.1 per cent $CaCl_2$ is remarkable in its magnitude. These mixtures required the longest setting time, the 1 per cent $CaCl_2$ mixtures were more rapid in setting, and those with only gypsum added set most rapidly. O. F. Honus (Zement Vol. 16. p. 3-5. Jan. 6, 1927.)

Concrete Work in England

Today there are 1,824 concrete roads in Great Britain and Ireland with an approximate area of 5,000,000 sq. yards, as against only 25 such roads in 1919. Anon. (The Structural Engineer, Lon. Vol. 5. p. 35. Feb., 1927.)

Reinforced Concrete Design

The actual distribution of stresses in a reinforced concrete beam is of a very complicated nature, and in order to be able to make calculations in practical design we have to adopt methods based upon reasonable assumptions which approximate the truth; as far as experimental evidence is available, the method of adding together the shear resistance given by bent-up bars and stirrups is a satisfactory one. In America it is still current practice to allow for the diagonal tension in the concrete; but it is interesting to note that in the recent draft of Joint Committee report the permissible stress has been reduced from 60 to 40 lbs. per sq. in.; we believe that ultimately the Americans will see the wisdom of neglecting it altogether. E. S. Andrews (The Structural Engineer, Lon. Vol. 5. p. 40-42. February, 1927.)

Manufacture of Slag Cement

The properties of slag puzzolana are utilized for the manufacture of three principal products which are (1) ordinary slag cement, (2) iron Portland cement, (3) Portland slag cement. The making of ordinary slag cement involves the intimate mixing and grinding cold, of the basic blast furnace slag and slaked lime. The slag must be basic, that is to say, its coefficient of basicity, $\frac{CaO}{SiO_2}$ must be greater than or equal to 1.

The flow sheet of the process may be summarized thus:

Slag (containing 20-30% H_2O)	Lime
↓	↓
Distributor	Vertical Furnace
↓	↓
Elevator	Slaking Tank
↓	↓
Trommel	Slaking Chambers
↓	↓
Wet Slag Bin	Extractors and Collectors
↓	↓
Rotary Dryer	Lime Elevator
↓	↓
Dry Slag Elevator	Bolting Mill
↓	↓
Dry Slag Storage Bin	Bolted Lime Elevator
↓	↓
Charging Regulator	Lime Storage Bin
	↓
	Charger

↓

Collector of Charged Products

↓

Elevator

↓

Compound Tube Mill

↓

Ground Product Elevator

↓

Storage Silos

↓

Automatic Sacking Machine

↓

M. G. Hugron (Le Ciment. January 1927. p. 2-9).

Cement

Cement or cement clinker is ground dry with casein, albumin, or protein, and oils, fats or argillaceous earths containing sebaceous or fatty acids are subsequently added with or without sulphur. Castings made from the mixture may be treated with an emulsion of paraffin in soap solution. Dufton & Obank (British Patent 244,973.)

FIELD CONTROL OF QUALITY OF CONCRETE*

DIFFERENT people have different conceptions of what is meant by "field control of concrete." It should be interpreted broadly to include the supervision of all the processes of concrete manufacture, that is, the supervision of: The quality of the constituent materials, i.e., the inspection necessary to insure a supply of cement, aggregates and water of the required quality; design of the mixture: i.e., the determination of the relative proportions (or quantities) of the constituent materials to give concrete of the desired quality; measurement and mixing of the constituent materials; placing and curing of the concrete; taking of the necessary field tests.

This report, however, only involves the second and more especially the importance from the economic standpoint of a careful consideration of the design of the concrete mixtures. The problem of the design of concrete mixtures divides itself into two parts, designing for quality and designing for economy. A design to be truly successful should give both the required quality and maximum economy but as in structural design, quality or ability to meet the demands made upon it in service can be obtained without reference to economy. For this reason the design of concrete for quality and for economy will be treated separately.

Investigations and experience indicate that the quality of the concrete is largely controlled by the relation between the quantity of the cement and water in the mixture, it being understood that the mixtures are workable and the constituent materials of proper quality. But it should be added that a truly workable mix can not be had without a sufficiency of fine aggregate and lacking this, the ordinary rules for the design of concrete cease to apply.

The underlying principles in maintaining the quality of a concrete is to keep a uniform relation between the quantity of water and cement in the mixture. For any given mix, the quantity of water may be increased or decreased as required to obtain the degree of workability desired, but at the same time, cement must be added or subtracted proportionately if the quality is to be uniform. Since the cement and water must be maintained in the same proportion, designing for economy demands that a combination of materials and conditions be found that will require the use of the least mixing water to obtain the desired results.

The amount of water thus necessary is governed first by the quality and character of the cement and aggregates, secondly by the proportions in which the materials are obtained and thirdly by the workability required. To this should be added another factor. That is the margin of safety that the engineer must allow in setting his mixture to provide for adverse job conditions such as variable materials, poor methods of measurement, poor workmanship, etc.

Much has been said on the advisability of using the driest possible consistency that can be handled and placed properly. If for argument, we assume a concrete designed to have a compressive strength of 2,000 lb. per sq. in. at 28 days, using sand graded from 0 to a No. 4 sieve and gravel from a No. 4 sieve to 1½ in., the cement required per cubic yard of finished concrete, as given by Abrams and Walker, is

Slump	Cement	Aggregate —Cu. Yd.	
In.	Bbl.	Sand	Gravel
½ to 1	1.05	0.42	0.71
3 to 4	1.17	0.42	0.69
6 to 7	1.44	0.36	0.72
8 to 10	1.88	0.28	0.67

Again, if we assume that cement costs $2.30 a barrel and sand and gravel $1.45 and $I.90 a cu. yd. respectively, the cost of material for these mixes becomes:

Slump	Cost of Material
In.	Per Cu. Yd.
½ to 1	$4.38
3 to 4	4.61
6 to 7	5.19
8 to 10	6.01

Those who have experimented in practice have found that it is possible to place, satisfactorily and economically, concretes of a consistency drier than ordinarily considered possible and that a mixture with a slump exceeding 3 to 4 in. is seldom required. If by a little forethought and planning, mixtures of a 3 to 4-in. slump can be substituted for those of a 6 to 7-in. slump, the economy resulting warrants the attention required to achieve this result.

This question can only be touched upon briefly here as it is to be dealt with in one of the committee's future reports.

Abrams recommends two water-cement ratio curves, one for the average job, and the other for the job that is closely supervised. Mixtures designed for the first condition required roughly a half bag of cement more for the same classes of half bag of cement per cu. yd. to provide for a lack of care in handling and measuring materials, workmanship, etc. In other words, the penalty that Abrams recommends for laxity in field control is roughly a matter of 50 to 60 cents per cubic yard of concrete.

*Briefed from report of committee C-6 of the American Concrete Institute presented before convention on February 22, 1927.

A Satisfactory Performance Under Unusual Conditions

Recently Charles E. Horne, Millbury, Massachusetts, was awarded a contract for the cutting and filling on 5,400 feet of road near Winchester, Massachusetts. For this work a Lorain 75 shovel was purchased and put into service on July 6, 1926. The shovel has a 1¼ yard dipper and 18 foot dipper stick, it is gasoline driven and travels on caterpillar treads. Because of its ability to handle large dippers of gravel and boulders and because it stood up under severe service, this shovel performed this difficult excavation successfully.

The operating conditions were unusually severe. The total excavation was 20,000 cubic yards along 5,400 feet of road. The material consisted of gravel and boulders with occasional hard pan. For a part of the distance an old road with a hard surface was torn up. The new road has an 18 foot metal or macadam surface and a 3 foot shoulder on each side, with a slope of 1½ to 1.

Some of the banks which were removed by the shovel were 26 feet in height, and the fills were, in some places, as deep as 15 feet. Practically every dipper load was swung through an angle of 180 degrees and the material dumped into 5 ton 5 yard Mack, Autocar and White trucks. There were 5 or 6 trucks in constant operation between the shovel and the dump, an average distance of 600 feet. When the work was first started a 90 degree swing was tried but the ground was so rough for the trucks that the method was changed, using a full 180 degree swing for the shovel.

The shovel handled 800 yards of this material in a 9 hour day, and an average of 465 yards per day was maintained over the 43 day period. Delays caused by lack of trucks, sticking of trucks in the soft ground and moving of the shovel account for the difference between the average and maximum production.

The shovel was operated at a cost of $43.78 per day. Fixed expenses, including depreciation and interest and a liberal allowance for repairs, amounted to $13.06 per day. One operator and a helper for pulling the rope, greasing, etc., cost $20.40 a day, gasoline, oil and grease amounting to $10.30 make up the balance. On sand, where both a steam shovel and the Lorain 75 would be suitable, the latter easily handled 1,100 yards in a 9 hour day.

The Lorain 75 has several valuable features which were used to advantage on this excavation work. The center drive truck makes the caterpillar tread merely an endless pad upon which the machine can travel, rather than a means of pushing or pulling it. Its ease of handling makes it possible for a good operator to work closely to grade, reducing subsequent operations of leveling off. The shovel traveled over rough, uneven and rocky ground where it seemed impossible that it could move. It also proved to have plenty of power to pick up heavy boulders that would severely tax a less sturdy machine.

New Incorporations

Chilhowee Stone Co., Charles M. Seymour, Empire Bldg., Knoxville, Tenn.

Winchester Sand & Gravel Co., Winchester, Ky. $30,000. J. C. Codell, R. D. Blanton. Acquired holdings of Winchester Granite & Brick Co. at Dudley, Ky., where crushing and pulverizing equipment will be installed.

Acme Shale Corp., Mt. Sterling, Ky. Harry S. Brower, Pres., 417 W. Third St., Lexington, Ky. Will establish plant to extract oil from shale.

Falling Spring Lime Co., Covington, Va. Guy G. Buell, Mgr. Developing quarry at Barber, Va.

Lacona Sand & Gravel Co., Watertown, N. Y. 500 shares, $100.00 each; 500 common, no par. H. D. and C. M. Ormsby, H. J. Yoder. (Filed by E. H. Bennett, Watertown.)

William J. McCormick Sand Co. $100,000. A. J. Conlon, J. L. Diamond. (Filed by J. A. Byrne, 305 Broadway, New York City.)

Intercontinental Marble Co. 7500 shares, $100 each; 20,000 common, no par. V. A. Pierson, J. Gralla, P. V. Gilfillan. (Filed by J. Gottlieb, Woolworth Bldg., New York City.)

Huntington Sand & Gravel Co., Huntington, N. Y. $30,000. F. J. Munder, R. Scudder, M. G. Gavin. (Filed by I. R. Swezey, Huntington.)

Cliffside Crushed Stone Co., Amarillo, Tex. $50,000. R. S. Nelson, W. D. Burger, Charles Nicholson.

K. D. S. Concrete Products Co., Griffith, Ind. $10,000. George E. Sloan, Doris Sloan, Walter Kline.

France Slag Co., 108th St. and Calumet River, Chicago, Ill. $250,000. (Ohio corp.)

Lautz Missouri Marble Co., Stevens Hotel, Chicago, Ill. $34,407. (Missouri corp.)

Kalon Products Co. of Delaware, Kansas City, Mo. $25,000. To manufacture, buy, sell, and deal in raw and calcined gypsum products. J. O. Patterson, Pres.; Roy K. Dietrich, Sec'y.

Pyramid Stone Co., Houston, Tex. $20,200. W. T. Carter; G. C. Street, Jr.; James L. Shepherd, Jr.

Alabama Rock Asphalt, Inc., Jasper, Ala. $65,000.

North Lake Sand & Gravel Corp., Milwaukee, Wis. 4,000 shares n.p.v. C. J. Otjen, Charles J. Petri, L. A. Garrity, Christopher H. Oman.

Pioneer Rock Asphalt Co., S. L. Mackey, Wilmington, Del. $500,000. (Corp. Service Co.)

Recent Patents

The following patents of interest to readers of this journal recently were issued from the United States Patent Office. Copies thereof may be obtained from R. E. Burnham, patent and trade-mark attorney, Continental Trust Building, Washington, D. C., at the rate of 20 cents each. State number of patent and name of inventor when ordering.

1,614,784. Segmental crushing-roll. Carl W Fingee, Wilkes-Barre, Pa.

1,614,979. Drag - line - excavator counterbalance. Harvey S. Cole and Norman A. Cole, Syracuse, Ind.

1,615,260. Process for the manufacture of fused cement and apparatus therefor. Georges Dumas, Viviers, France.

1,615,284. Shoveling-machine. Arthur T. Kennedy, Duluth, Minn.

1,615,315. Concrete mixture. Harry J. Shaw, Toledo, Ohio.

1,616,240. Disc crusher. Edgar B. Symons, Hollywood, Calif., assignor to Symonds Brothers Co., Milwaukee, Wis.

1,616,354. Cement building forms. John A. and Lee M. Comer, Calexico, Calif.

1,616,357. Concrete-wall form. Otto L. Engstrom, South Bend, Ind.

1,616,460. Clamp for concrete forms. Paul A. Melvin, Chicago, Ill.

1,616,472. Screen. Albert H. Stebbins, Los Angeles, Calif.

1,616,564. Mine-car. Leopold Almquist, New York, N. Y., and Victor Willoughby, Ridgewood, N. J., assignor to American Car & Foundry Co., New York, N. Y.

1,616,573. Mine-car. Harry P. Field, Berwick, Pa., assignor to American Car & Foundry Co., New York, N. Y.

1,616,578. Mine-car. Warren V. Johnson, Bloomsburg, Pa., assignor to American Car & Foundry Co., New York, N. Y.

1,616,597. Mining-machine. Thomas E. Pray, Chicago, Ill., assignor to Godman Mfg. Co., same place.

1,616,673. Creeping-traction mounting for railway-type excavators. Svante R. W. M. Bager, South Milwaukee, Otto F. Kaeser, Milwaukee, and Werner Lehman, South Milwaukee, Wis., assignors to Bucyrus Co., South Milwaukee, Wis.

DISTRIBUTION OF CEMENT

Portland cement shipped from mills into States in November and December, 1925 and 1926 in barrels*

Shipped to	November		December	
	1925	1926	1925	1926
Alabama	161,142	134,009	108,906	117,426
Alaska	132	173	132	297
Arizona	36,310	27,412	61,646	39,536
Arkansas	43,423	79,627	43,281	42,245
California	972,874	887,351	938,721	901,526
Colorado	61,541	61,057	30,872	31,711
Connecticut	148,990	147,288	56,260	52,141
Delaware	24,504	17,682	13,680	6,528
District of Columbia	106,642	78,369	57,119	64,457
Florida	251,285	418,696	439,786	317,402
Georgia	104,559	161,710	69,046	110,139
Hawaii	8,410	21,417	20,735	25,732
Idaho	19,245	25,409	15,993	13,199
Illinois	817,588	776,758	407,808	446,515
Indiana	233,595	289,720	114,856	108,771
Iowa	96,762	116,116	41,325	37,153
Kansas	172,945	169,035	87,368	88,010
Kentucky	99,170	120,647	63,382	62,172
Louisiana	75,513	74,619	74,464	89,843
Maine	17,453	19,168	7,028	6,255
Maryland	140,656	212,972	85,377	135,181
Massachusetts	258,733	234,087	133,365	72,231
Michigan	537,713	702,901	302,889	292,167
Minnesota	168,138	87,777	62,943	40,916
Mississippi	53,244	61,685	34,740	60,858
Missouri	478,531	315,318	207,230	152,647
Montana	13,819	16,169	7,382	6,455
Nebraska	82,528	64,198	34,633	26,933
Nevada	5,751	4,751	4,015	3,150
New Hampshire	35,808	32,190	22,586	18,340
New Jersey	566,337	688,736	329,054	255,744
New Mexico	16,735	18,965	10,258	13,639
New York	1,249,902	1,584,352	889,639	788,046
North Carolina	200,447	276,568	152,699	183,912
North Dakota	9,531	8,969	2,474	2,439
Ohio	545,452	651,257	339,030	312,336
Oklahoma	226,437	225,767	148,354	120,560
Oregon	73,583	75,541	46,531	47,637
Pennsylvania	945,344	1,013,955	597,328	469,376
Porto Rico	577	7,250	0	13,250
Rhode Island	50,609	47,278	26,721	19,313
South Carolina	69,234	46,692	54,545	31,523
South Dakota	14,080	10,076	6,379	3,625
Tennessee	104,657	124,551	80,322	82,556
Texas	280,852	419,358	284,061	303,770
Utah	24,607	34,358	21,135	12,944
Vermont	9,301	14,455	4,066	3,844
Virginia	104,185	127,290	72,698	61,351
Washington	106,111	131,602	82,364	90,856
West Virginia	80,179	104,150	63,066	63,680
Wisconsin	173,988	169,068	77,100	95,776
Wyoming	9,403	8,160	7,968	7,430
Unspecified	29,247	54,253	8,140	396
	10,117,802	11,200,962	6,851,500	6,354,439
Foreign Countries	69,198	75,038	65,500	77,561
Total shipped from cement plants	10,187,000	11,276,000	6,917,000	6,432,000

*Includes estimated distribution of shipments from three plants in November and December, 1925, and from five plants in November and December, 1926.

Production, shipments, and stocks of finished Portland cement, by districts, in January, 1926 and 1927, and stocks of barrels, in December, 1926

Commercial District	January Production		January Shipments		Stocks at end of		Stocks at December
	1926	1927	1926	1927	1926	1927	1926*
Eastern Pa., N. J., and Md.	2,765,000	2,510,000	1,469,000	1,422,000	3,805,000	5,122,000	4,034,000
New York	623,000	318,000	205,000	165,000	1,447,000	1,438,000	1,284,000
Ohio, Western Pa. and W. Va.	523,000	527,000	382,000	411,000	2,455,000	2,576,000	2,460,000
Michigan	292,000	448,000	212,000	261,000	1,994,000	2,085,000	1,898,000
Wis., Ill., Ind., and Ky.	542,000	923,000	476,000	461,000	3,574,000	3,444,000	2,982,000
Va., Tenn., Ala., and Ga.	961,000	899,000	845,000	921,000	966,000	1,173,000	1,196,000
Eastern Mo., Ia., Min. & S. Dak.	435,000	509,000	281,000	247,000	2,979,000	3,199,000	2,936,000
West., Mo., Neb., Kan. & Okla.	225,000	468,000	325,000	398,000	1,556,000	1,847,000	1,777,000
Texas	330,000	383,000	308,000	365,000	502,000	461,000	444,000
Colo. Mont. and Utah	48,000	121,000	73,000	77,000	392,000	517,000	473,000
California	1,034,000	974,000	984,000	1,088,000	533,000	551,000	665,000
Ore. & Wash.	109,000	142,000	114,000	140,000	379,000	469,000	467,000
	7,887,000	8,222,000	5,674,000	5,956,000	20,582,000	22,882,000	20,616,000

*Revised.

Domestic hydraulic cement shipped to Alaska, Hawaii, and Porto Rico, in December, 1926†

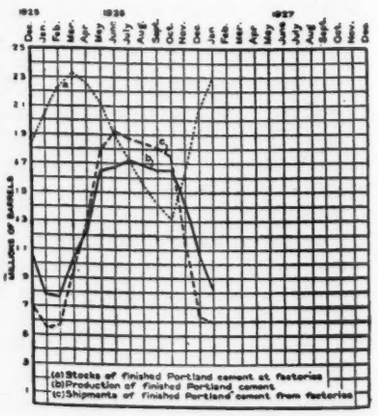
	Barrels	Value
Alaska	2,086	$ 5,872
Hawaii	22,497	50,362
Porto Rico	20,970	50,971
	45,553	$107,205

†Compiled from the records of the Bureau of Foreign and Domestic Commerce and subject to revision.

JANUARY CEMENT STATISTICS

January production, shipments, and stocks of Portland cement show increases over the corresponding period in 1926 according to the Bureau of Mines, Department of Commerce. Production shows an increase of over 4 per cent and shipments an increase of 5 per cent, as compared with January, 1926. Shipments of Portland cement exceed those of January in all other years.

Portland cement stocks at the end of January, 1927, are over 11 per cent greater than at the end of January, 1926, and are exceeded only by those at the end of March, 1926. These statistics, prepared by the Division of Mineral Resources and Statistics of the Bureau of Mines, are compiled from reports for January, 1927, received direct from all manufacturing plants except four, for which estimates were necessary on account of lack of returns.


1925
1926
1927
(a) Stocks of finished Portland cement at factories
(b) Production of finished Portland cement
(c) Shipments of finished Portland cement from factories

New Dust Proof Compensator

A new General Electric automatic compensator, of dust-proof design for high voltage service, is recommended for service where dust is excessive, such as coal crushing plants, flour mills, etc. This device has a maximum rating of 65 amperes at 2200 volts.

The side and top covers are securely bolted to angle-iron straps. The back cover is removable but, when in place, is held there by spring clamps. This back cover gives ready access to the current transformers, auto-transformers, wiring and contactor-operating mechanism. The front cover is securely clamped to the base with a flange and gasket around the edge. The compensator is arranged for conduit wiring. The conduits enter at the back through a bushing plate. The device bears the designation CR-7051-Y-1.

Production, shipments, and stocks of finished Portland cement, in 1926 and 1927, by months, in barrels

Month	Production		Shipments		Stocks at end of month	
	1926	1927	1926	1927	1926	1927
January	7,887,000	8,222,000	5,674,000	5,956,000	20,582,000	22,882,000
February	7,731,000	.....	5,820,000	.....	22,385,000	.....
March	10,390,000	.....	9,539,000	.....	23,236,000	.....
1st quarter	26,008,000	.....	21,033,000	.....	.....	.....
April	12,440,000	.....	12,965,000	.....	22,710,000	.....
May	16,510,000	.....	17,973,000	.....	21,255,000	.....
June	16,866,000	.....	19,134,000	.....	19,000,000	.....
2nd quarter	45,816,000	.....	50,072,000	.....	.....	.....
July	17,134,000	.....	18,812,000	.....	17,301,000	.....
August	16,995,000	.....	18,583,000	.....	15,718,000	.....
September	16,571,000	.....	18,087,000	.....	14,188,000	.....
3rd quarter	50,700,000	.....	55,482,000	.....	.....	.....
October	16,596,000	.....	17,486,000	.....	13,334,000	.....
November	14,193,000	.....	11,276,000	.....	16,243,000	.....
December	10,744,000	.....	6,432,000	.....	*20,616	.....
4th quarter	41,533,000	.....	35,194,000	.....	.....	.....
	164,057,000	.....	161,781,000	.....	.....	.....

*Revised.

EXPORTS AND IMPORTS*

Exports of hydraulic cement by countries, in December, 1926

Exported to	Barrels	Value
Canada	632	$ 2,555
Central America	8,827	42,980
Cuba	9,278	22,562
Other West Indies	5,804	14,485
Mexico	4,575	14,001
South America	52,957	163,270
Other countries	7,903	45,385
	89,976	$305,238

Imports of hydraulic cement by countries, and by districts, in December, 1926

Imported from	District into which imported	Barrels	Value
Belgium	Florida	20,577	$ 39,262
	Galveston	3,580	5,073
	Maine and New Hampshire	5,797	12,480
	Massachusetts	60,916	86,258
	New Orleans	16,812	25,888
	New York	b	5
	Oregon	30	44
	Philadelphia	17,753	26,703
	Porto Rico	3,241	5,339
	Total	128,706	$201,052
Canada	Vermont	655	1,480
Denmark and Faroe Islands	New York	b	9
	Porto Rico	13,005	20,882
	Total	13,005	$ 20,891
France	New York	2,324	5,381
Germany	Porto Rico	1,054	2,350
Japan	Hawaii	1,001	1,958
United Kingdom	Los Angeles	2,877	9,102
	Maryland	250	465
	Massachusetts	500	787
	New York	1,478	2,827
	Total	5,105	$ 13,181
	Grand total	151,850	$246,293

Exports and imports of hydraulic cement, by months, in 1925 and 1926

Month	Exports				Imports			
	1925		1926		1925		1926	
	Barrels	Value	Barrels	Value	Barrels	Value	Barrels	Value
January	71,596	$ 207,547	72,939	$ 216,431	231,258	$ 364,196	360,580	$ 576,717
February	56,249	181,356	73,975	220,706	119,077	206,308	314,118	527,948
March	65,248	200,410	69,080	205,647	218,048	337,039	493,241	812,968
April	89,508	263,831	96,296	284,772	197,686	280,326	257,302	398,114
May	85,385	250,845	78,601	224,365	186,897	286,959	223,130	337,031
June	71,343	217,899	80,684	248,814	254,937	409,539	335,570	495,744
July	98,141	286,543	130,822	370,220	335,118	499,602	250,862	395,981
August	103,961	289,904	64,946	216,489	379,847	611,551	350,638	560,532
September	102,649	285,225	70,920	239,174	513,252	789,121	194,129	308,224
October	73,369	228,467	69,389	225,374	535,050	824,268	263,403	386,335
November	101,825	294,201	76,598	238,103	388,604	678,518	55,233	82,949
December	100,323	296,900	89,976	305,238	295,543	526,001	151,850	246,293
	1,019,597	$3,003,128	974,226	$2,995,833	3,655,317	$5,813,928	3,250,056	$5,128,836

*Compiled from the records of the Bureau of Foreign and Domestic Commerce and Subject to revision.

Motor Companies Amalgamate

The Relay Motors Corporation, recently incorporated to take over all assets of the Commerce Motor Truck Company and Service Motors, Incorporated, announced today the officers of the amalgamated company. In 1925 E. W. Bassick, E. S. Evans and W. R. Bassick acquired control of the Commerce Motor Truck Company, increasing and expanding its manufacturing and sales activities. Through the efforts of E. W. Bassick, the amalgamation of companies was completed, and its policies will be outlined by him. W. R. Bassick is chairman of the board of directors of the new company.

G. L. Gillam, president of Relay Motors Corporation, was president of Service Motors, Incorporated prior to the amalgamation. Mr. Gillam has been president of the Service Motors, Incorporated since 1923, coming from the International Harvester Company. M. A. Holmes, vice-president, will have charge of all sales. He has been director of sales for the Commerce Motor Truck Company and was vice-president and salesmanager of the Republic Motor Truck Company. A. K. Taber, formerly treasurer of Service Motors, Incorporated, is secretary and treasurer of the new company.

The amalgamation enables not only the manufacture of the Commerce truck, but the manufacture also of the Relay Drive truck. The drive on this truck is claimed to be the most important step forward since the inception of the commercial vehicle. Six years have been spent in perfecting the Relay drive under the most severe tests. While its engineers do not claim the drive is any radical departure from accepted mechanical principles, it does represent a distinct advancement in motor truck design.

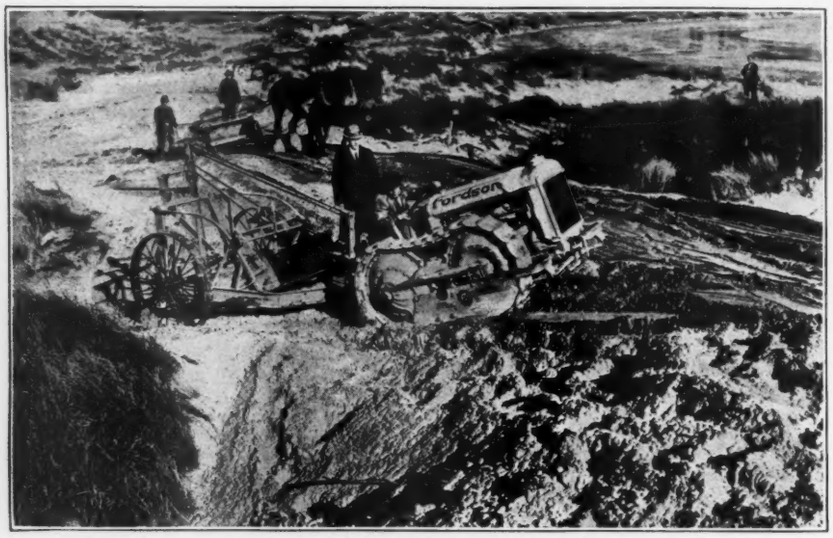
Officials of the new company state that the manufacture of both Service and Commerce trucks will be continued and the combined capitalization will provide for an aggressive merchandising campaign for both the Commerce and Service lines, as well as the new Relay line.

Pennsylvania Crusher Company Changes Personnel

The Pennsylvania Crusher Company announces that John Alden Plimpton has been appointed western manager, in charge of the Chicago office, effective February 1, 1927, to succeed Mr. C. S. Darling.

Crawlers in Foreign Fields

The road building industry is spreading rapidly in foreign countries which can be accounted for by the fact that the rapid progress of the automotive industry has made absolutely necessary improvements in road construction everywhere. The illustration, taken in a foreign country, shows a Belle City crawler, Fordson equipped and a Miami scraper building roads under very difficult soil conditions.



Fordson crawler and scraper in foreign field

Fast's Flexible Coupling

The Fast flexible coupling is manufactured by The Bartlett Hayward Company and is described in a catalog recently issued by this company. This coupling does not depend upon the resiliency of materials, and thus its life is not limited by the fatigue and failure of materials. It is an all metal, double engagement flexible coupling, deriving its flexibility from a design based on a simple mechanical principle. This is two spur gears, one on each shaft end, completely meshed with the internal gears of a floating sleeve. It is able to transmit power at low or high speed with equal effectiveness.

This coupling is self contained, dustproof, and will operate continuously where dirt, dampness or heat are unavoidable. It is a definite piece of machinery and therefore in common with all transmission units, it is positively lubricated. Positive lubrication insures the life of the coupling to be equal to that of the connected machines. There are three possible forms of misalignment between two shafts connected endwise; offset, angular and a combination of offset and angular and this coupling compensates successfully all these errors.

A slight clearance between the external and internal gears permits a definite error of alignment between the two shafts. The error between the gear faces, due to the principle of design, is only a small fraction of the corresponding error of alignment between the shafts.

The coupling consists of two hubs each connected to its respective shaft. Each hub has a generated spur gear cut at the maximum possible distance from the shaft end. Surrounding the hubs is a casing or sleeve which is transversely split in its center and bolted together by means of flanges. Each half of this casing has a generated niternal spur gear cut on its bore at the end opposite its flange. These internal gears engage the external gears. Supporting rings positively control the center line of each gear, intercepting the center line of the casing at the transverse center lines through the load carrying surfaces. The coupling is filled with oil at the oil collector rings, or through oil hole in the hub, carrying an oil level up to the lip of the ring. With oil to this level, the revolving of the coupling spreads the oil over the inner circumference of the casing. The gear teeth are then entirely submerged in an oil bath under pressure due to centrifugal force.

G. E. Steel Switchboards

A simple construction of steel switchboard panel, with several outstanding advantages, can now be furnished by the General Electric Company. The construction is such that the new board partakes of the conventional switchboard features to an extent that makes it possible even to install the new and old types together, temporarily or permanently. Combinations of steel and slate or ebony asbestos panels on one board will be practicable with the use of the new design.

General Electric pipe supports are retained on the steel panels. Each panel can be shipped completely wired without unusual care and bracing in packing. In erecting the board, the framework is set up first, and the individual panels are then installed one by one. The panel wiring is grouped in trough-shaped recesses at the sides of each panel. When installing slate or ebony asbestos panels adjacent to the new steel design, the so-called angle-pipe construction of support is used; i. e., the former are mounted on light angles placed ⅛ of an inch inside the edges of the panels. These angles serve to support the several sections of the panels, and the wiring during shipment. The dimensions of the steel panels with their supporting edges are the same as those of corresponding slate or ebony asbestos panels with supporting angles. The rounded edge of the steel panel matches the rounded edge on the next steel panel, or the ¼ or ⅜-inch bevel on the adjacent old panel. The new panels are made in standard widths of 16, 20, 24, 28 and 32 inches, with a standard height of 90 inches.

Blakeslee and Sons Exhibit at New Haven

A progress exposition was held in New Haven, Connecticut, from January 26 to February 5 of the present year. The total number of people who attended was 250,000 and the largest number in attendance on one day was 26,432. The number of exhibitors was 220 and the number of employees on the Exposition payroll was 169. The floor space occupied was more than twice the size of the Grand Central Palace in New York City. The cost of setting up the Exposition was $60,000.

One of the exhibitors was C. W. Blakeslee and Sons and their exhibit was interesting and viewed by many people during the days of the exhibition. The exhibit consisted of a cross section of the New Haven Harbor showing the pivot pier of the famous Tomlinson Bridge and a cross section of the Lift Pier of the New Tomlinson Bridge. Several oil paintings were shown of the progress in quarry work and underground power and transmission line work. A cofferdam about which a derrick and a pile driver, with leads and hammer, were in operation. A model stone crushing plant in operation showing the crushing of stone was another exhibit. One of this company's divers dressed in his suit and helmet with an attendant to explain his operations to the crowd was also interesting.

Patterson Ball and Tube Mills

The Patterson Foundry and Machine Company recently issued a catalog describing the Patterson Ball and Tube Mills. These ball and tube mills are built from the same patterns, the difference between the two being simply that of length. The tube mill as a fine grinder is built longer in order to subject the material to prolonged action of the balls or pebbles. The cylinders are lined with either silex or hard cast iron and in some instances with porcelain and other special liners. Grinding balls are made of a mixture of iron, chromium and manganese. The pebbles are imported from France, and sometimes porcelain balls are also used. These ball and tube mills may be operated in several ways, namely: open circuit, closed circuit, dry grinding with separator, dry grinding with screens, or wet grinding with classifier.

The separator used in the Patterson system is adapted to the closed circuit system of grinding and is built in various sizes. This separator eliminates blowers, cyclones, dust collectors, or auxiliary apparatus. It readily separates any desired mesh from 60 to 350 of an analysis running from 75 to 99 per cent and can be positively adjusted for any given mesh and when set for any desired fineness, produces a uniform product irrespective of any variation in speed. As it operates at slow speed, there is practically no wear. Some of the construction features in the mill are as follows. The heads are of semi-steel and are heavily reinforced with ribs. The heads are machined inside and out, rivet holes drilled, and rivets driven hot. A seat is turned in each head to receive the ends of the shell which are machined and practically all mills are re-turned in lathes after assembly to insure proper alignment. Seams are electrically welded.

The main bearings are of the ball and socket self-aligning type of a generous area to prevent overheating and also to allow an opening through the gudgeon for the feeding and discharge of the material. The mills are mounted on heavy base plates and the lubrication is by means of hard grease requiring attention about every four to six months.

Over 75 per cent of these mills now sold, are equipped with direct motor drive which is a simple and satisfactory method of operation. It permits a certain amount of flexibility which is so desirable in driving this class of machinery. The drive consists of a specially designed silent chain running in an oil and dust tight casing. The gears, chain and all parts are of generous size to insure satisfaction and long life. The casing is of heavy gauge metal and contains lubricant to insure all parts receiving sufficient lubrication. Motors up to 40 H.P. are self compensating, internal resistance type, having 250 to 300 per cent starting torque. These motors are especially adapted to pull dead loads and thus are suited for ball and tube mill installations. Motors over 40 H.P. are slip ring type and supplied with complete starting equipment.

International Combustion Acquires the Heine

International Combustion Engineering Corporation officially announces the acquisition of the capital stock of the Heine Boiler Company, one of the oldest and leading water-tube boiler manufacturers in the United States. This acquisition gives the International Combustion Engineering Corporation large boiler shop facilities at St. Louis, Missouri, and Phoenixville, Pennsylvania. All types of water-tube boilers will be manufactured at St. Louis, including the new Sinuous header type recently placed on the market. The manufacture of the Ladd water-tube boilers and the new Combustion steam generators will also be centered in the St. Louis plant.

The acquisition of the Heine Company will enable the International Combustion Engineering Corporation to furnish to its customers complete steam generating units fired with pulverized fuel or mechanical stokers, all of its own manufacture. Mr. C. R. D. Meier will remain as president of the Heine Boiler Company.

New Clipper Speed Lacer

The Clipper Belt Lacer Company has recently developed and introduced a new speed lacer known as Number 8. This new lacer is the most powerful and most efficient of the clipper line. It will lace both ends of an 8-inch belt in 1½ minutes, necessitating only one operation for each end of the belt.

The lacer has a pressure of 45,900 pounds, which is ample for embedding hooks uniformly flush with an 8-inch belt surface in one operation. While formerly it required two operations to lace one end of an 8-inch belt in about five minutes, now it can be done in one operation in less than a minute. This Number 8 laces all belts from one inch up to and including eight inches in width in one operation, any belt from 8 inches to 16 inches, two operations; and up to 24 inches in three operations.

American Continuous Filter

The United Filters Corporation has issued bulletin Number 130 describing the American Continuous filter. This device is claimed to be the latest development of vacuum filters. In the original design and subsequent improvements of this filter the company has aimed toward the development of a machine that would combine mechanical simplicity, strength and durability with maximum economy and dependability of operation. It is entirely automatic and continuous in operation requiring no labor or supervision aside from occasional adjustments and cloth renewals.

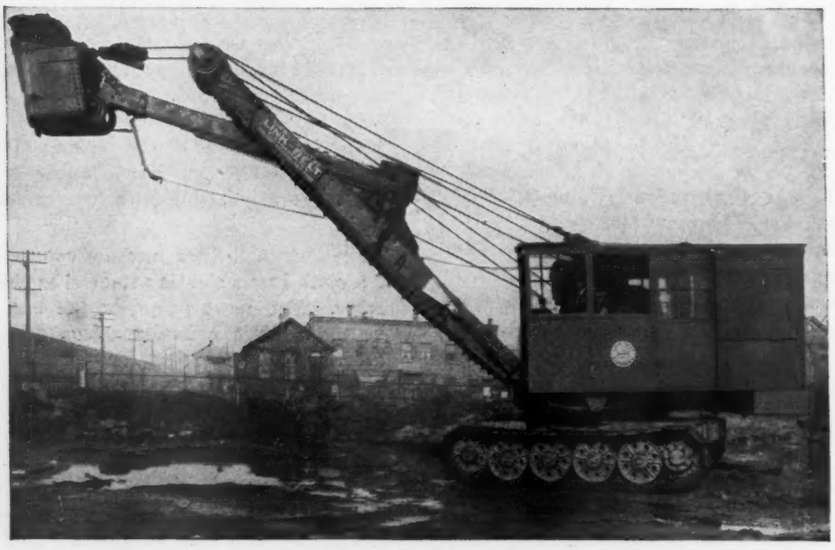
Some of the construction details of the filter are as follows: The individual filtering unit is called a sector and for standard construction is formed of three pieces of selected, clear grained California Redwood or Cypress, depending on conditions to be met. These are deeply corrugated on both sides and assembled on a light cast iron drainage cap by means of two steel sector rods. A curved wood strip, half round in section, completes the peripheral edge of the sector while U-shaped strips of hard maple or metal are attached to the two radial edges.

The standard filter medium consists of a cloth bag which is attached to the sector. For most purposes the bags are made from a heavy cotton twill cloth specially woven for filtration purposes, but for certain materials and conditions of service other weaves of cloth are preferable. Depending on the size of the machine, from eight to ten of the sectors are assembled around a hollow shaft to form a complete filter disc. The sectors are held in position by threaded radial rods provided with nuts. The center shaft is made of hollow cast iron of ample proportions. It is divided into sections consisting of heavy cylinders cast with a number of cored filtrate channels parallel to the axis. All sectors in a horizontal row are connected to one hroizontal filtrate channel by means of drilled holes in the shaft at the base of each sector. Thus each horizontal row of sectors is drained and controlled by one filtrate channel which in turn is controlled by the filter valve.

The filter valve is a rotary valve of the conical plug type. It has the advantage of being self seating which eliminates the possible loss of vacuum through leaks. The filter tank, in which the lower portion of the filter discs are submerged, is usually built of heavy sheet metal with riveted or welded points. It is suspended from the channel side bars by cast iron brackets.

New Link Belt Shovel

A new super-duty machine of 1¼ cubic yard capacity, known as the Link-Belt K-42 shovel, with over-size brakes, clutches, drums and other working parts, is now being produced by the Link-Belt Company. Shown for the first time at the Good Road Show, the new K-42 machine is designed with the thought in mind that the various kinds of digging and the speed of operation which should reasonably be expected from a machine of this capacity, subjects it to innumerable shocks and terrific strains. The working parts of this new shovel are large and liberal. It is not, the makers assert, a 1 cubic yard machine stretched to 1¼ cubic yard, but rather, through its over-size equipment, permits readily of 1¼ cubic yard capacity operation under the most gruelling conditions.



New Link Belt Shovel

All rope speed changes in the new shovel are taken care of merely by changing the drum shells, to vary the drum diameter, and by changing the engine pinion. In this way the machine can very quickly and easily be converted from shovel to dragline, crane, trench shovel, etc. A complete line of popular appurtenances, such as the boom for the dragline, or general crane service, trench shovel and skimmer, are available for the shovel. Strength, ruggedness, flexibility, speed of operation, over-size working parts, and large capacity, are the special features claimed for the new shovel.

Street Cableways

Street Brothers Machine Works, Inc., has issued bulletin Number 56 describing the Street cableways and hoists. This bulletin shows by a number of illustrations and line drawings how cableways and hoists are being used for transporting and handling material in construction and excavation operations. For quarry work a cableway can be used to advantage for stripping and handling the quarry product. For transporting material over streams, sorting of piling in yards, a cableway can also be used successfully. The successful operation of a cableway as well as the initial cost depends in a large measure on the fall rope distributing devices and the methods of installation. With this in mind this company has devoted much study to this subject and have prepared formulas, charts, etc., relating to these problems. The cableway engines have been designed and are constructed to withstand severe service. These engines embody all the essentials that make a rugged machine. the gears are of cut steel, large diameter shafts are used and bearings of generous lengths. Drums are cast in three pieces, assembled with through bolts, and then balanced. Traction drums are made of close grained iron so as to resist the wear of the running ropes. Large crank discs balanced for high speed eliminate vibration. The reversing gear is of the Stephenson link motion type.

The electric hoist is of the same construction as the steam hoist. For semi-portable cableways, the traction drums are of the spool type, and on permanent installations grooved drums are furnished. By a special control system the same action is obtained on the electric hoist as on the steam. By this control the cableways can pick up a partial load at any desired speed. In the change of speed it assumes a gradual acceleration. For spotting speeds this even speed is most advantageous.

On the carriage of the cableway system no spacing chains, button ropes or other cumbersome appliances are necessary for discharging or spacing the carriers at the predetermined intervals. A simple device discharges the carriers at their proper place, and provides for their being picked up on the return. The carriage is of substantial construction and an equalizing arrangement distributes the load on all four sheaves, saving wear on the rope as well as the sheaves. The horn, the part extending along the track rope, is balanced by counterweights and a parallel motion prevents strains in the crosshead, horn or bumper.

New G. E. Motors

A new type of induction motor which, with its control, is even simpler to operate than the ordinary squirrel cage motor and compensator, is announced by the General Electric Company. A complete line of these motors, bearing the type designation FT and ranging in ratings from 7½ to 50 horsepower, has been placed on the market.

The FT motor is in general suitable for application wherever the ordinary squirrel cage induction motor with a compensator has been used. It is designed to start on full voltage giving slightly higher starting torque but approximately the same starting current as the ordinary squirrel cage induction motor started with the compensator connected to the 80 per cent tap.

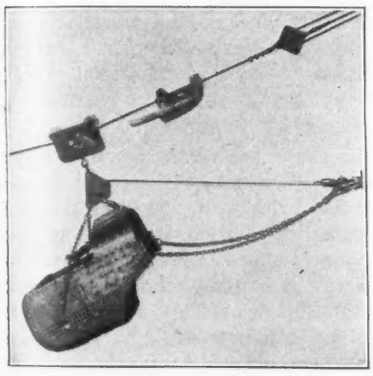
Control apparatus required is very simple. An ordinary line switch of proper capacity can be used, but, in order to obtain proper overload and undervoltage protection, the motors are recommended for use with magnetic starting switches using push button control. Where necesary, on the larger sizes, a compensator or resistor starter may be used as in the case of the ordinary squirrel cage induction motor.

Used Equipment Bulletin

The Southern Iron and Equipment Company has issued its February bulletin of railway, logging, contractors' and industrial equipment. This bulletin shows a portion of the stock owned by this company and which is ready for delivery. In it are illustrated and described locomotives of various types and tractive powers, flat cars, rail and sectional track, steam shovels of different makes and capacities, locomotive cranes, railroad ditchers and three sizes of dump cars, 4, 6 and 12 yards capacity respectively.

Page Slackline Cableway

During the past ten years, the Page Engineering Company has developed several different devices for the operation of their bucket on a slackline cableway installation. They have just completed a new device for locking the bucket and permitting it to dump by gravity which they believe is superior to all other methods on the market at the present time. The digging ability of the Page bucket, its long life under severe operating conditions, the well known reliability of the Page Engineering Company combined with an efficient locking device for slackline installations makes this installation particularly desirable to prospective purchasers.



Page cableway

The Page cableway control differs from other devices in that the bucket is locked in position above the hopper grizzly in such a manner that it dumps by gravity. While locked in this dumping position, the operator can shake the bucket at will in order to free it of any sticky material. The bucket is released by a short forward pull. The operation of the locking device is entirely automatic being performed by an arm that is locked in a device resembling a boot-jack. The release is also automatic. It is absolutely positive as the bucket always locks in position when the carriage and the arm on the lock meet and it is released by a short forward pull on the bucket. If the load cable is released quickly, the bucket will dump quickly. If it is released slowly, the load will be dumped as slowly as the operator desires. The ability to hold the bucket and to shake it at will above the hopper grizzly appeals to slackline cableway users. It is also noticeable that this bucket does not require additional power to dump it, as like all other Page buckets on boom type draglines, it is dumped by gravity.

Stripping operations can be handled with the bucket without the aid of a tripping or locking device. Therefore, this bucket is especially desirable for that class of work as it increases the speed of operation to a great extent. All that is necessary in stripping is to release the load line when the desired point at which the bucket is to dump is reached. The bucket dumps immediately by gravity when the tension on the load line is released. It is particularly noticeable that the method of operation of the Page cableway control permits the use of a device and of a bucket that is free of numerous chains and complicated mechanism. This is very desirable as it means lack of trouble and fewer parts to wear out and replace.

The improvement shown in the Page cableway control makes this installation a very welcome addition to the ones already in the slackline cableway field. The Page Engineering Company announces that they are prepared to sell a complete slackline cableway installation. This means that they will furnish the Page scraper bucket, the slackline carriage, steel mast, two speed Thomas hoists, all blocks, cables, etc., necessary to a complete installation.

Belle City Company Holds Annual Meeting

At the annual meeting of stockholders of the Belle City Manufacturing Company held recently the following directors were elected: Frank K. Bull, Stephen Bull, Harry A. Reed, William G. Thompson, Walter J. Tostevin, David G. Janes, Thomas B. Myers. Following the meeting of stockholders the directors elected the following officers: President and Treasurer, Stephen Bull; Vice President and General Sales Manager, Harry A. Reed; Secretary, Walter J. Tostevin; Assistant Secretary and Assistant Treasurer, George A. Nelson.

The outlook for 1927 was reported as very favorable both on Crawlers and Threshers and sales reports since the beginning of the fiscal year, November first, show an increase of over 150 percent over last year for the same period. The company has had a large demand from their distributors for their 28x48 thresher, which they are now building all steel and equipped with Timken roller bearings, and this in connection with their individual and neighborhood sizes will give them full production on threshers.

The Belle City crawlers show a very largely increased demand and indications point to a good volume of sales on both clutch and differential controlled models. The "E" is the narrow type used for plowing, logging, in orchard work, etc., while the "EE" is the wide type with a track measuring the same width between tracks as between the regular Fordson wheels to which can be attached practically all industrial equipment used by producers, contractors, road builders, etc. A very satisfactory part of this demand comes from foreign fields where these crawlers are well established both in agricultural and industrial work.

Northwest Adds to Line

In answer to the demand for a machine handling a 1 cubic yard dragline bucket on a 50 foot boom, the Northwest Engineering Company has added the Type M to their line of small machines. This type has all the features of the Model 104. When handling pipe it is possible, by using a 3-part line, to handle a 6-ton load at a 32 foot radius with a 40 foot boom. The caterpillars are long and wide, 16 feet 4 inches x 11 feet 6 inches, providing a stable base that offsets the tipping load. The machine can be shipped without dismantling. A choice of two power plants is available, either a 4-cylinder gasoline engine or the Northwest 4-cylinder Diesel engine.

New Northwest unit

Now the Mann Company, Inc.

The Mann Iron & Steel Company, Inc., has changed its name to The Mann Company, Inc. The officials of the firm are Aaron Mann, pres. and treas.; Hyman Mann, vice-pres.; Harry Mann, sec.; John Frimmel, supt. The company opened a quarry in 1922 and is now one of the largest producers of crushed stone in their vicinity. The plant is located at Mogees, Plymouth Township, Pennsylvania, between the Pennsylvania R. R. & Reading R. R., the property line running parallel with the two railroads.

The quarry face is 75 feet high and this company is now getting ready for a second bottom which face will be 40 feet high. The firm plans to run upper and lower levels this year. The Mann Company stone meets state highway specifications for all types of construction. Most of their stone is sold to the State Highway of Pennsylvania for highway use. The Company plant is fully equipped with modern machinery and they recently purchased a Link-Belt gasoline shovel for stripping the overburden from their quarry.

New Thew Shovel

The Thew Shovel Company has established an innovation in the development of its latest product; the Lorain-60 one yard shovel, crane and dragline. In the past when changing conditions made a larger capacity machine necessary for standard use, it has been common custom to step the old standard machines up to the larger capacity. This meant strengthening of parts throughout to meet the increased working strains.

New Lorain one yard shovel

The Lorain-60 however is the Lorain-75, a 1¼ yard machine, stepped down to one yard capacity. It is the Lorain-75 in everything but dipper capacity, power plant, power take-off and counterweight. It retains all the strength and other advantages of the 75. It has the same interchangeability of booms; shovel, crane or dragline. It will handle a crane boom up to 50 feet in length and can be counterweighted for unusual stability. When the Lorain-60 owner develops the need of a larger capacity machine, he does not have to dispose of his one yard machine to replace it. By substituting a Lorain-75 power plant and accessories he has a full 1¼ yard machine in every respect.

Bethlehem Track Equipment

The Bethlehem Steel Company recently issued Catalog K describing the Bethlehem mine and industrial track equipment and other products. This catalog has been prepared for the purpose of presenting information relative to Bethlehem products for use in mine and industrial track construction. It contains such information as will be necessary for ordering such products, as well as other data, tables, and calculations which will be of interest to users of light rail equipment.

The catalog is divided into sections, describing the various products. Frogs suitable for any type of service may be selected from the many designs illustrated. Riveted-plate frogs may be used for light traffic and the rigid-bolted type, fitted either with or without base plates, are adaptable for the average industrial track when traffic is medium. For locations where traffic is extremely heavy, rail bound manganese or solid manganese frogs are recommended.

There is no more vital element entering into track construction than the switches with which a property is equipped. Several typical designs are given to illustrate the types of switch construction which will meet most requirements. Switch stands of the following types are shown: Parallel throw, positive and automatic. Several types of guard rails manufactured by this company are described and the best service for which they are designed is given.

Crossings for use in mines, quarries and other locations where the rail is lighter than 30 pounds per yard, are usually of the riveted plate type, and may be furnished in either single rail or the guarded two rail designs. Various designs of tie plates, rails and joints are also shown as well as miscellaneous equipment used for the installation of tracks.

New Anchoring Method for Lining Walls

The flexo-anchor is a device that allows a one piece monolithic furnace wall to move in any direction with expansion and contraction, providing for the difference in expansion and contraction between the common brick and the refractory lining. And at the same time it anchors the refractory to the common brick wall, effectually preventing bulging. It has just been announced by the Plibrico Jointless Firebrick Company, manufacturers of Plibrico furnace lining.

Three years ago the rigid anchor was introduced by the same organization. Three years of use under boilers of all types proved the rigid anchor to be a big step ahead in monolithic practice, so the manufacturers state. The flexo-anchor is a further refinement and development which brings the additional advantage of allowing for expansion.

The new anchor is a very simple device. The hook is secured in the common brick wall. Then as the wall of plastic Plibrico is built up the anchor is placed over the hook. As the wall rises the anchor is embedded in the Plibrico. This new anchor is used in both new settings and repair jobs. On old brickwork a brick is pried loose. Then the hook is inserted into the wall and the brick is firmly wedged back into place. Each drum of jointless Plibrico Furnace Lining shipped out now contains a flexo-anchor under the head.

Hill Clutch Machine Makes New Appointment

The Hill Clutch Machine & Foundry Company recently appointed Charles C. Phelps as sales engineer for the Metropolitan New York and Northern New Jersey district. The manufacture of the Hill Clutch Machine and Foundry Company includes everything for power transmission such as shafting, couplings, bearings, clutches, pulleys, sheaves, belt tighteners, speed transformers, agitators, gears, and sprockets. The featured products of the company are, the Cleveland type oil-film bearings, Smith type friction clutches, steel arm automatic belt tighteners, Forged Cast spur gears, industrial type spur gear speed transformers and flexible couplings.

H. C. Shields Joins Weller

H. C. Shields, who is well known to our readers for his work in the cement industry both as a consulting engineer and plant executive for more than twenty years, has joined the Weller Manufacturing Company as sales engineer.

Fifty Years of Service

The Western Wheeled Scraper Company has recently issued a book under the above title which describes in an historical manner the progress of this company since its advent in 1877. The book is dedicated to the founders and builders of this company, Capt. W. Beckwith, Capt. C. H. Smith and Dr. A. W. McClure. From a small beginning in a makeshift plant at Mount Pleasant, Iowa, this business has grown to the great enterprise occuping a modern and model plant covering 48 acres of ground.

Fifty years ago there was practically no road work except in its cruder forms. The railroads were in their infancy. There were no steam shovels or dump cars to make modern railroad engineering possible, most of the work was done with pick, shovel and wheelbarrow. Such were the tools with which a firm of veteran contractors, C. H. Smith and Company, were doing railroad work back in 1877, when they became interested in a crude wheeled scraper that had been devised. This scraper held about three cubic feet of material. The pan was made of wood with a steel bottom. The point cleared the ground but the heel dragged. There was no shaft. A handle had been pivoted to each side with cross bars to connect and the scraper was loaded and dumped by raising the handle. The next stage in the development was a pan made of steel, in four pieces riveted together, with an axle on top and wheels about three feet in diameter. This proved to be an awkward and unwieldy machine and the only way it could be dumped was down hill. Nevertheless, Capt. Smith founded a company for its manufacture, then called the Western Wheel Scraper Company.

Shortly after the organization of the company the wheeler was put into the hands of experts, who improved it so rapidly that it soon bore little resemblance to the original machine, and it finally reached its present form. Meanwhile the young company had brought out an improved, all steel drag scraper, practically the type now in use. Such, briefly, is the history of the Wheeled Scraper from which the company took its name. This name was changed to Western Wheeled Scraper Company when the company moved to their present location in 1891.

This company has also been interested in the development of dump cars which it manufactures. The rocker type of dump car was invented in Germany and introduced into the United States in 1886 or 1887. However, side dump cars were not built by this company until 1893. These cars were of one and one quarter cubic yards capacity. The growing demand for larger loading units resulted in a gradual increase in the size of dump cars until in 1900 the company was building cars of six cubic yards capacity. Large double dump cars were first built in 1903 which were ten cubic yards capacity. In 1904 the company designed cars of twelve cubic yards capacity for operation by air, used in the construction of the Panama Canal. The company then brought out an air dump car of eighteen and two-thirds cubic yards capacity. This eighteen and two-thirds yard car afterwards was developed into the standard twenty cubic yard car.

The book is profusely illustrated with half tones showing the various types and sizes of dump cars, elevating graders, wheeled scrapers, Western-Aurora steel rock crushers, elevators, gravel screening plants, road drags, etc., and is not only a book of historical value but also of interest to those using any of these machines or attachments.

Sturtevant Air Separators

The Whirlwind Centrifugal Selector is described in Catalog Number 87 recently published by the Sturtevant Mill Company. The separation of finer from coarser particles by the use of centrifugal force and controlled air currents is not new, its principle and application is known and has been in practical, though limited, use for many years. Only recently, however, owing to the increasing demands for finer products and exacting specifications of users of such materials, a complete re-designing of the old type air separator was necessitated to meet the requirements of modern processes.

With the advent of the modern slow speed, low powered separator, supplied as an independent unit, a great step was made in the act of fine sizing. It has allowed the preliminary grinder, in two stage reduction, to add its fines to that of the finisher without the grinding of that portion already sufficiently ground. It has made possible closed circuit grinding wherein a pulverizer is not handicapped by the necessity of reducing to the required fineness, at the first pass, all that is fed to it. Theory and practice both prove that any pulverizer can produce more fines if more material passes through it; that is, if the feed or circulating load is increased and the machines are not required to grind to a finish within themselves. Thus if a grinding mill has a maximum output of 5 tons per hour, discharging all its product 100 mesh, this same mill, fed at the rate of 10 tons per hour, discharging 80 per cent of its product 100 mesh, has an actual capacity per hour, to the same fineness, of 8 tons, without additional power. An air separator accomplishes this by taking the entire discharge of the pulverizer, removing the fines as soon as made and returning the rejects or oversize to the mill for grinding.

A brief description of the Sturtevant Whirlwind Selector is as follows: The feed, usually from a pulverizer, enters the top of the selector passing through a rotary mixing and feeding device and falling upon a large rotating distributing plate whereon it is spread into a thin even film and thrown by centrifugal force outwardly towards the inside surface of the inner drum. The agitator, just above the distributing plate, creates a strong whirlwind action within the drum, causing through the action of centrifugal force, a segregation of the material being whirled. A large upper fan acts as a whirling sucker and causes an upward draft through the lower and into the upper compartment. This draft is of the correct strength to oppose and overcome the centrifugal effect upon particles of a given weight which detach themselves from the mass and follow the upward current into the outer drum chamber and are here, again, whirled, gradually settling by gravity into the lower drum or hopper. The inside drum is separated from the outer chamber by an adjustable plate, open at the center only, so that particles coarser than desired would have to work their way against centrifugal force, around a corner to the center of the machine before they could mix with the material in the fines compartment. The air from the fines compartment returns to the inner drum, to be used over again, through whirl creating valves which allow the air to pass through without carrying with it the centrifugally held fines. By regulating the centrifugal effect and air suction, it is possible to select, with most materials, a product as coarse as 40 to 50 mesh, or as fine as 97 to 98 per cent through 350 mesh.

J. C. White Joins Blaw-Knox

Blaw-Knox Company announces a valuable addition to its engineering and selling staffs in the person of Mr. John C. White, President of the Arrowhead Iron Works of Pennsylvania, Inc. Mr. White has recently joined the organization of the Blaw-Knox Company and has been appointed Sales Manager of the Steel Grating and Flooring Department. He will be located at the General Offices of the Blaw-Knox Company at Pittsburgh.

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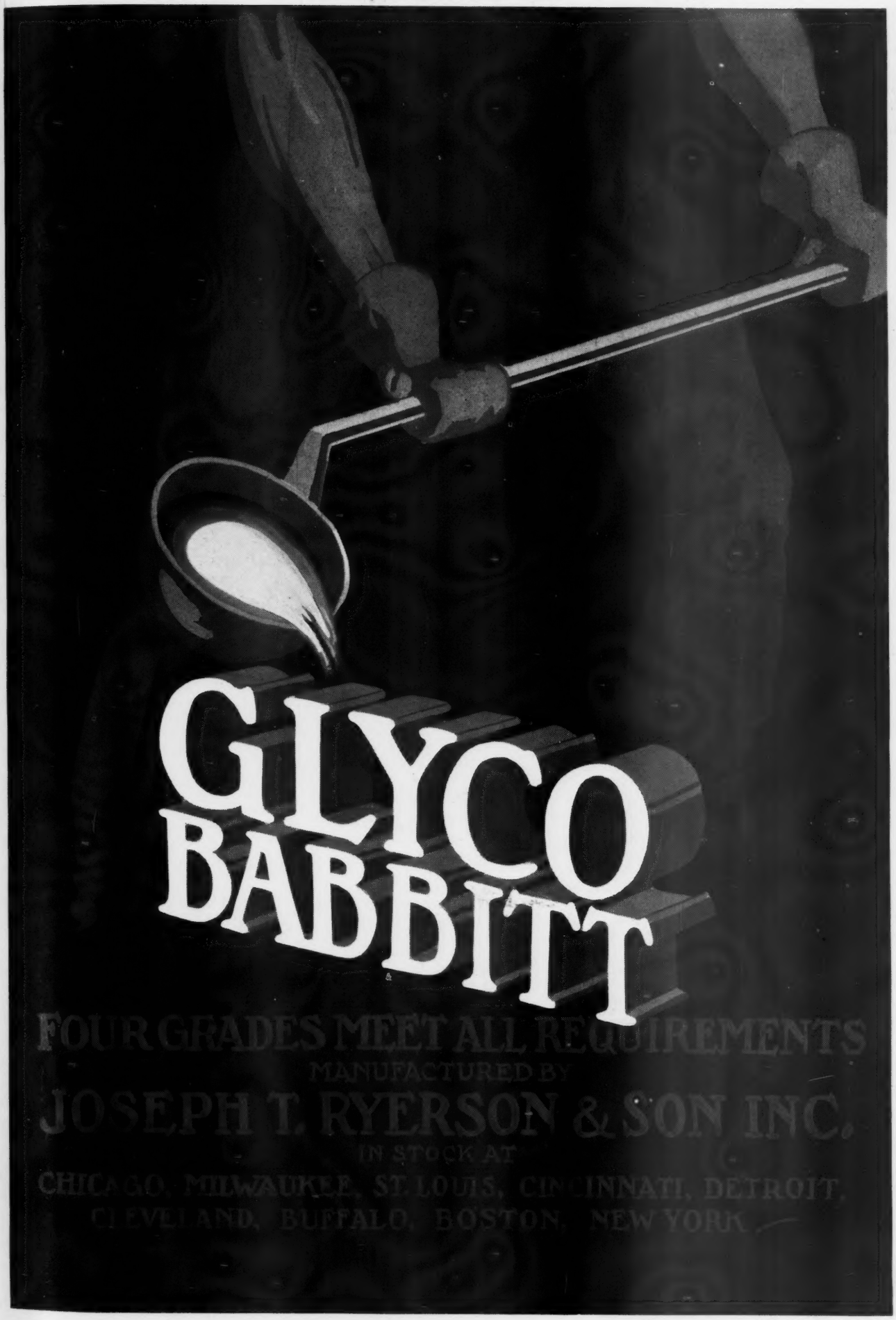
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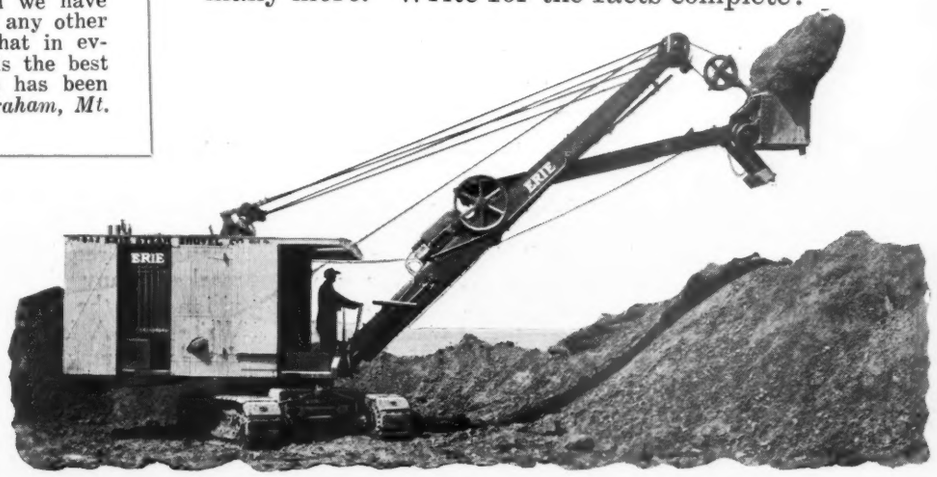
The two letters at the left are merely samples of many more. Write for the facts complete!



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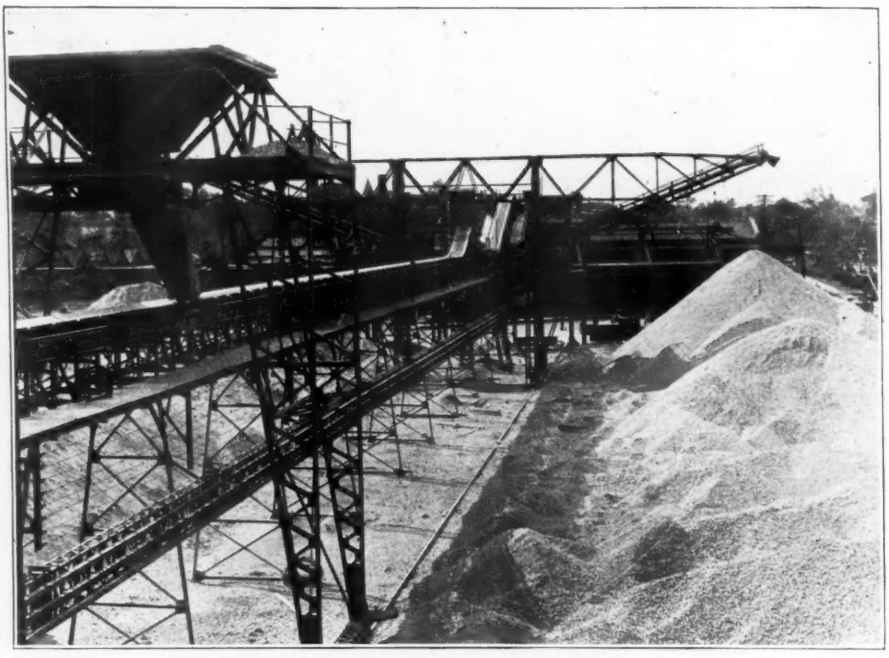

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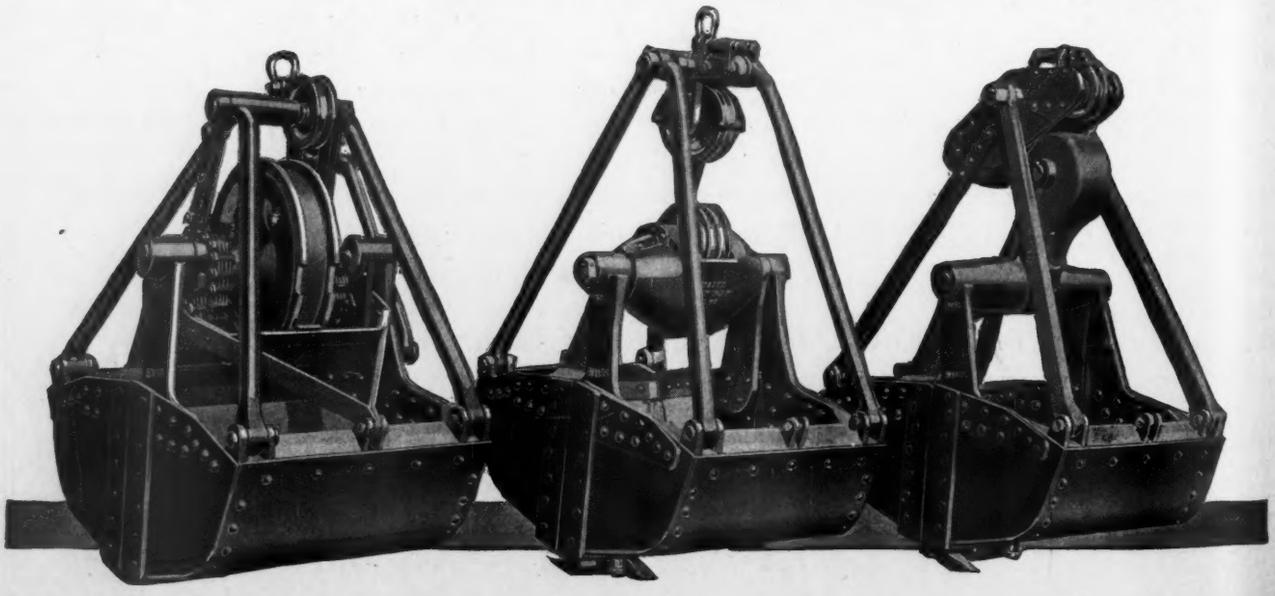

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Pit and Quarry

Vol. 13 CHICAGO, ILL., MARCH 16, 1927 No. 12

THE PUBLISHERS of PIT AND QUARRY and Pit and Quarry HAND BOOK deeply appreciate the letters received complimentary of the 1927 edition of the HAND BOOK and desire to thank those Readers and Manufacturers who have expressed their pleasure.

STIMULATING SAFETY THROUGH THE INTERNAL HOUSE ORGAN

DURING the past year the National Safety Council conducted a prize contest for plant magazines. The house organs were judged by a competent committee on a point basis, according to the following scale:

Safety	40 points
General Interest Ideas	20 points
Educational Ideas	15 points
General Character	10 points
Make-up	10 points
Unusual features	5 points
	100 points

The magazines were judged on a point, rather than a percentage basis. This means that 40 per cent of a house organ need not be devoted to safety in order to earn a rating of 40 points in that division. In fact, one or two good safety pages might count for much more than a half dozen mediocre ones. Similarly the other items in house organ make-up were judged on a quality rather than a quantity basis. The comparative size of the various plant publications, and the facilities of their editors were also taken into consideration.

Final awards of the judging committees were somewhat of a surprise to many house organ editors. Without going into the details of the final standing it is sufficient to say that many establishments were disappointed to find their publication so far down in the list. One of the best ways to learn and to grow is by seeking the reason for the success of the leaders and then profiting by this knowledge. A few remarks on the general aims of a good plant publication, and on some of the methods followed by the successful house organ editors might therefore prove helpful.

The primary function of a successful employe magazine should be:

1. Creating good-will, company spirit and cooperation;

2. Developing pride in the job, spreading news of promotions, awards and plant advantages;

3. Safety education;

4. Mental advancement, thrift, sound economic and technical or process education;

5. Home stimulation, and family good will development.

Since the subject of safety education is one of the major reasons for the existence of house organs, let us see how some of the successful publications handle safety data in their columns. More than 75 per cent of the industrial accidents that occur are due to the personal equation. The mere adoption of mechanical safeguards will therefore by no means eliminate such accidents. It is only by educating the workers to think and act safely that safety records can be established and maintained. Accordingly, safety education is a mixture of psychology of the human emotions, coupled with the best methods of putting the lessons across.

In an issue of one of the leading house organs, the principal article tells how one department's safety record was broken by John Jones who slipped and sprained his knee on a wet floor. Mr. Jones' name is played up in the headline with the result that he was subjected to considerable "kidding" by fellow employees. Nevertheless, his fellow workers were careless in not properly cleaning up the floor so that Jones, in not watching his step, was hurt partly because of the negligence of others.

In many successful magazines accident occurances are turned into news items. The victim's name is featured, the complete details of the accident are given, and the physical sufferings and economic losses are pointed out. Following such news stories, ways and means for preventing such accidents are always outlined. Another good practice is to publish safety pictures, posed for by the employees themselves. Such pictures appeal both to the posers and their fellow workers. Some plants find the humorous cartoon with an under-

lying safety lesson more effective than the "horror" pictures.

Health articles by the plant physician, or by a neighborhood doctor known to many of the workers are also efficient safety stimulants. A good location for these articles in the magazine is among the home news, family or women's pages, where they will receive the support of the home folks. Preaching and patronizing attitudes should be avoided. The editor should get out on the "field of action" to learn the particular items and desires of each group in the plant. For example, the men in the packing room were trying to keep their department records free from a lost-time accident blemish. One of the workers had a finger badly cut. The injury was properly dressed by the plant physician and the worker insisted on going back to work instead of staying home a day or two just to help keep the department record 100 per cent clean. The editor played up this story properly and soon other departments began to request write-ups.

Safety is a state of mind, as well as a habit. Stimulation must be constant, but varied and interesting. One suggestion is to feature individual subjects in each issue, as for example, goggles, then proper shop clothing, then small tools, etc. Articles on safety in the home are also helpful. Attractive posters and safety bulletins help greatly, as do slogans, limericks, and mottos. The development of the employees' interest in the magazine, encouraging them to contribute articles, and to foster the teachings of the publication—these are concomitant builders of a successful plant publication.

INDUSTRIAL MARKETS ARE NOT WHERE THEY USED TO BE

AMERICAN industry is transitory, not stationary. There is no more fixidity about industrial centres or distribution problems than there is about football championships, dancing, or the mode of feminine hair-dress. Whether rapid or gradual, everything is mobile, and this fact should be kept firmly in mind by every industrial executive. Just now, as we ever have, we are witnessing a gradual shifting of industrial centers. The increasing and ever changing population, coupled with the development of new sources of raw materials, gives rise to new routes and methods of transportation, and makes necessary constant alteration to industrial methods and marketing practice.

Not so long ago New England was the industrial center of the United States. Brockton and Lynn were the major points in the shoe and leather industry, while Lowell and Lawrence held supremacy in textiles. This was because New England was for the most part peopled with those trained in the industries of Great Britain. Today the shoe and leather industry is scattered from one end of the continent to the other, while the textile industry is rapidly spreading itself over the South where may be found the raw material, water power, cheap labor, and fair transportation.

Canada and Wisconsin are rapidly undermining the supremacy of Maine and Massachusetts in paper making; California and the Southwest have taken predominance from the Keystone state in the matter of oil; the steel industry of Pittsburgh has suffered by the inroads in both prestige and production made by the Lake Michigan plants, while the culmination of the St. Lawrence-Great Lakes-to Gulf waterways idea should serve to immensely enlarge the commercial importance of the middle west.

Any plan for marketing finished products must take into consideration the westward shifting center of population—formerly in eastern Pennsylvania, now in a western Indiana village. Manufacturers have met the situation by what is commonly known as decentralization, or by moving themselves bodily to the newer and larger fields.

New inventions and trends of thought play an important part in marketing. Style changes are carried swiftly by radio, press and motion pictures, with the result that San Francisco knows and incorporates changes as quickly as New York. The "Black Bottom" is danced in the logging towns of Wisconsin to the strains of the same orchestra as the dancers on a Manhattan roof garden—because of radio. There is no remoteness any more. Articles which sell in the East will likely find the same appeal in the West. Labor saving devices and industrial innovations are as eagerly sought in one section of the country as in another. We are rapidly becoming a closely knit and amalgamated lanadaa, maanaa:Cfld,ii o'cryam dketin gamated land, manufacturing and marketing. The executive who recognizes the shifting tide of population, similarity of intersectional tastes and desires, new routes of transportation and new centers for manufacturing, is an alert official and the one most likely to reap the largest harvest.

1. OLD MAN EXPERIENCE SAYS

The world reserves its big prizes for but one thing—and that is initiative. "Initiative" is doing the right thing without being told. Next to doing the thing without being told, is to do it when you are told once.

MANUFACTURE OF SLAG CEMENT

By M. G. Hugron

THE pozzolanic (volcanic) properties of slags are used for the manufacture of three principal products, which are:

1. Ordinary slag cement.
2. Iron Portland cement.
3. Portland slag cement.

The manufacture of the two last of these products has made continual progress and their quality may now be compared with that of the Portland cements. We shall describe in this article only the manufacture of the ordinary slag cement, which is by far the one most commonly used in France.

Ordinary Slag Cement

The ordinary slag cement is obtained by mixing and grinding purely, at a low temperature, the basic slags of the blast furnaces and slaked lime. The slags used (Scoria) must be basic: that is to say their coefficient of basicity $\frac{CaO}{SiO_2}$ must be greater than 1 or at least equal to 1. These Scoria are found on the hot fire bridge of the blast furnace. They have a yellowish or bluish appearance. This distinguishes them easily from the dross obtained from the colder fire bridge. These are darker and not suitable for manufacture. The basic slags, the most used, are those which become granular in water, for these crush more easily than those obtained in other ways.

Composition of the slags of the French blast furnace (after Pritsch):

Silica	30.50
Lime	48.00
Aluminum	19.00
Iron oxide	0.85
Magnesium	0.50
Sulphate of lime	0.50
Magnesium oxide	0.40
Other elements	0.25
	100.00

Lime. The lime used for the manufacture must be perfectly slaked and should contain no unburned and no overburned material. The particles of the lime which are not slaked run the risk of producing expansive cements, especially if they have not been perfectly powdered. All the limes are suitable for the manufacture of slag cement. The fat limes used increase the solidity of the product but give it a tendency to crack during the setting in an atmosphere lacking in moisture. The hydraulic limes give with the slag a product of very good quality. The density of the slag cement obtained is inferior to that of the Portland cement. We shall describe below the process which has been adopted for the construction of a factory after Andelys.

Composition of the manufactured product: 70 per cent of dry slag; 30 per cent of lime.

Chemical analysis of the burned lime stone used:

Silica	1.50
Aluminum	1.55
Iron oxide	0.30
Lime	88.75
Carbonic acid	3.25
Magnesium	0.65
Sulfuric anhydride	0.70
Water	2.85
Not determined	0.45
	100.00

Plan of Manufacture

Slag (20 to 30 per cent of water)	Lime
Carrier	Vertical kiln
Elevator	Slaking tank
Revolving screen	Slaking chambers
Feeding box or hopper for moist slag	Extractors and collectors
Rotary drier	Elevator for lime
Elevator for dry slag	Bolting mill
Spare hopper for dry slag	Elevator for bolted lime
Charging regulator	Spare hopper for lime
	Screw charger

↓

Collector of charged products

↓

Elevator

↓

Compound grinding mill

↓

Storage silos

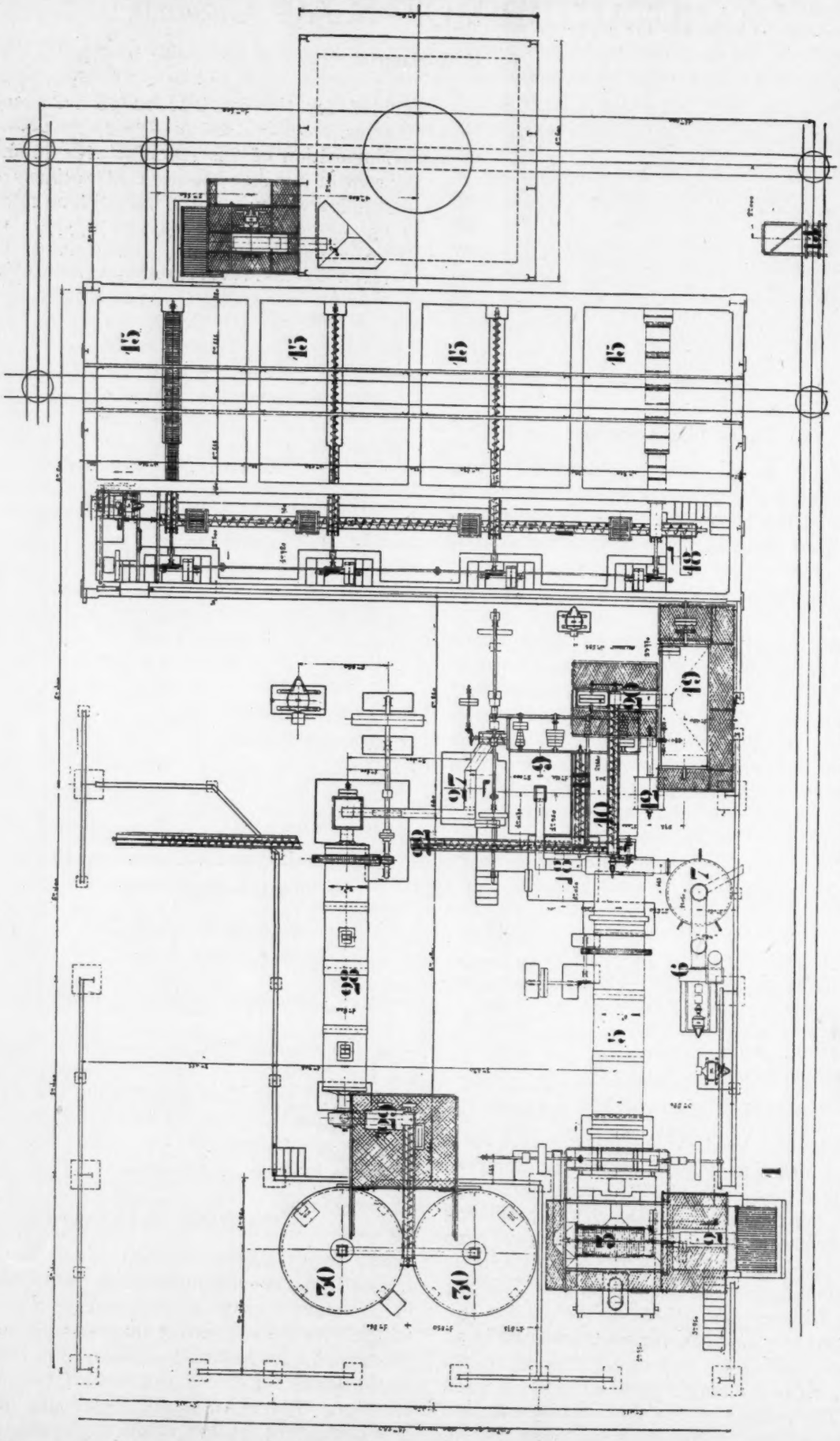
↓

Automatic sackers or baggers.

In the manufacture, a product is incorporated for the regulation of the time of setting of the cement and a product for the uniformity of the color. These two products contained in the reserve hoppers are turned into the collector of charged products by helix distributors.

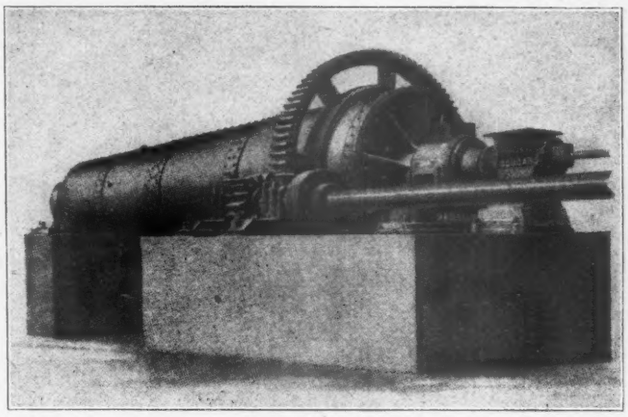
Preparation of Dry Slag

The moist slag is brought in small cars and turned into a hopper for loading. (1) The hopper in its upper region is equipped with a grating where bars are 1½ inches apart for the sorting of the large pieces and with a drawer-like distributor in the lower region for the regular feeding of an elevator. The elevator for moist slag (2) is of the continuous bucket chain type, and at automatic tension.



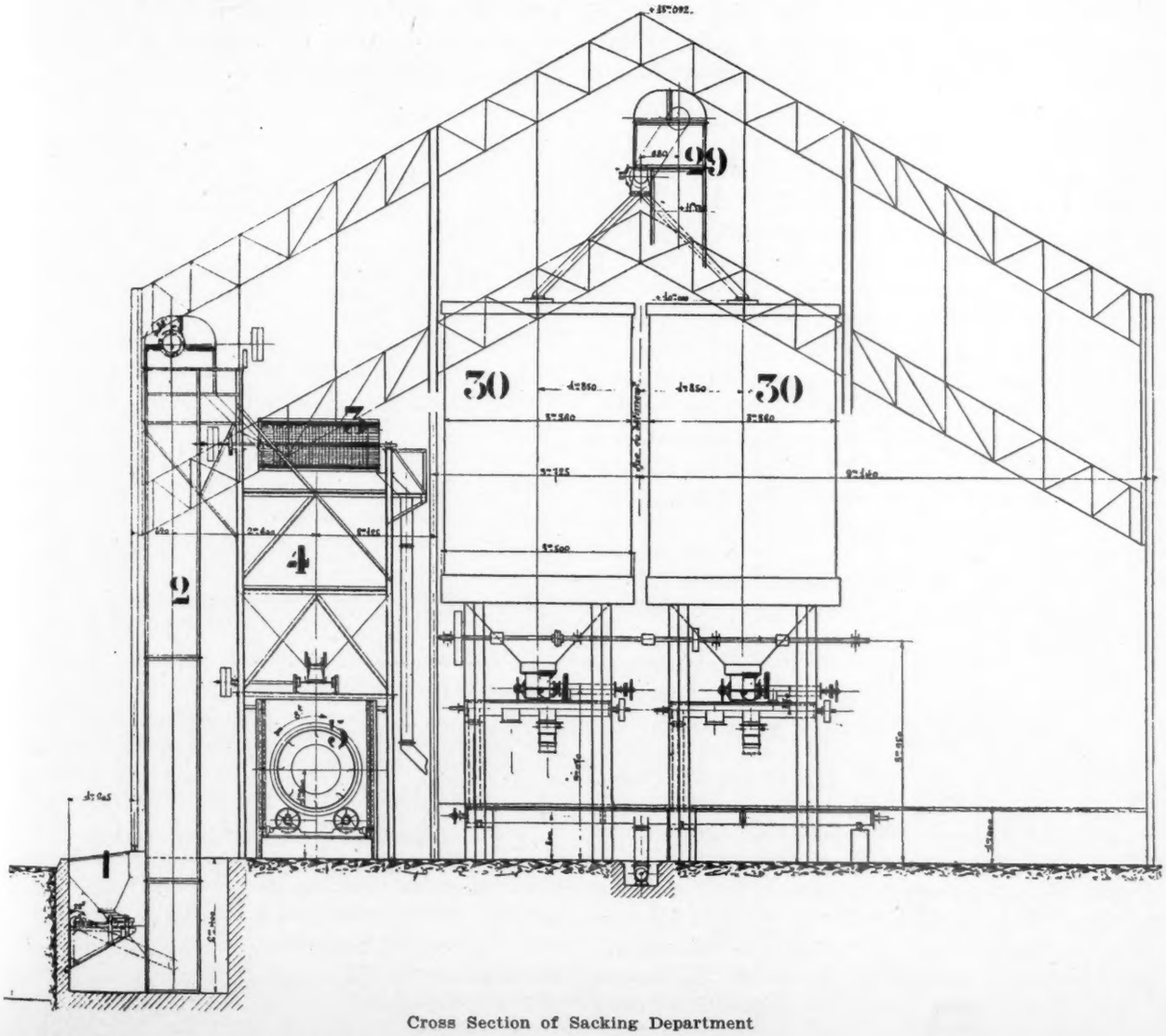
Diagrammatic View of the Plant

The slag, being a very abrasive substance, special precautions have been taken to avoid the dragging of the buckets at the foot of the elevator and to reduce the wear and tear on the machinery to a minimum. The elevator supplies a revolving screen (3) with oblong perforations which operates a complementary sorting of the pieces which might prove a hindrance to the organs of distribution to the different machines. The small-sized product tumbles into a hopper kept for moist slag (4), the refuse into a discharge flue and into a car taken to the dump. The lower part of the hopper is closed by a drawer-like distributor whose action is adjusted to that of a double eccentric which feeds the trough leading to the drier.

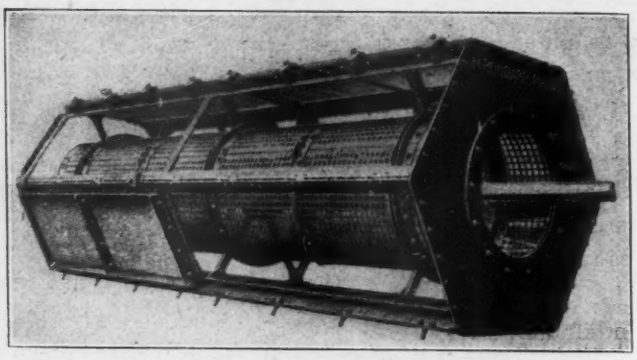


A Rotary Dryer Jacket

In the rotary drier used (5) the circulation of the gases is parallel and in the same direction as that of the slag to be dried. This arrangement allows the warm gases to come immediately in contact with the moist products and has the effect of avoiding the sudden increase in heat on the collar of the dryer walls, without spoiling the quality of the slag used. The revolving part of the dryer is made up of jackets very solidly put together by joint-covers, and carries plates for the wear and tear. These may be easily replaced at the place where the slag is fed in. The interior is equipped with paddles for mixing and with paddles for propulsion. These may be regulated in such a way as to increase or reduce the length of the passage of the material in the drier.



Cross Section of Sacking Department



The Hexagonal Bolting Mill

On the jacket are mounted:

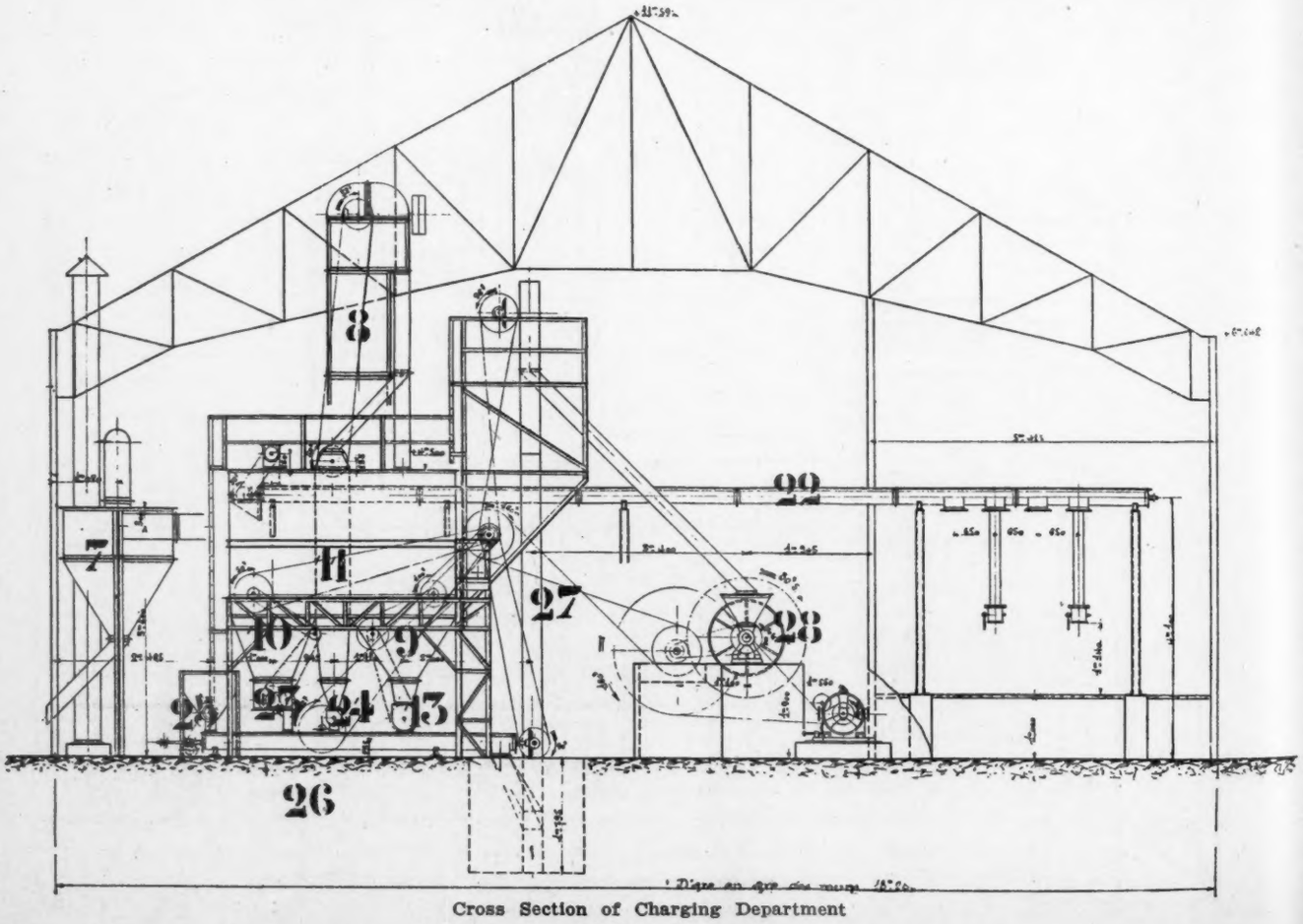
1. The two hoops which roll in alternate brackets like a flywheel.
2. The controlling gear on flexible plates.

The method chosen for the erecting of the hoops and of the gear has as object the free expansion of the dryer wall in every direction, the avoidance of any sheltering of the pieces, and any dislocation of the riveting. The hoops turn on rollers carried by oblique bearings. These last are supported by bases of polished cast iron. The longitudinal adjustment of the mechanism is assured by means of horizontal cleats that are fixed upon the hoop nearest to the gear. The collar at its passage into the masonry of the hearth and at the jacket where it emerges is strengthened by turning and sliding joints which prevent the entrance of injurious gases.

A ventilator takes in the warm and moist air which passes into a cyclone where it is purified from dust. Then it is sent out into the outer atmosphere. The paddles of the ventilator are also efficiently protected against rapid wear. The hearth is equipped with all necessary dampers for the regulation of the amount of cold air which must be mixed with the fumes coming from the hearth. The dried matter falls into a container, then passes by a pipe or flue to an elevator of dry products. This is constructed on the same principle as those of the elevator of dry slag.

Slag Hopper

The elevator of dry products feeds a reserve hopper, mathematically constructed along such dimensions as will suffice for the output of an entire day's work. The group of hoppers, dry slag (9), bolted lime (10), additions, (11), for coloring (12) are very rigidly mounted and are erected upon a framework of composite girders. The lower part of the slag hopper is closed by a damper or register controlled by a system of levers which allow for easily displacement.



Cross Section of Charging Department

Slag charger (13). This is made up of a trough, equipped with suitable regulators. In it turns between both ends a strong shaft of square section. On this shaft blocks are fastened. The blocks are of cast iron and fit one as well as the other. They carry paddles adjusted at such an angle as to force the material inward. The shaft is controlled by a functioning of gear and of cones arranged in tiers. These make it possible to obtain all the speeds desired.

Lime. The lime extracted from the place of recovery of the kiln is carried in cars under a slaking tank. This sprinkles over it, automatically, the amount of water necessary for its slaking. The cars are then overturned into basins where the lime rests the necessary time in order to be completely slaked. Then the lime is retaken from each basin by means of extractors which may, according to the need, be of the screw type or of scrapers. Each of the extractors, controlled by a gear with clutches, distributes the lime into a collector, which takes it to a bolting mill by means of an elevator, by means of an automatic system of chains.

Bolting Mill. The bolting mill is of the hexagonal type, and cylindrical, for removing stones. It is made entirely of iron.

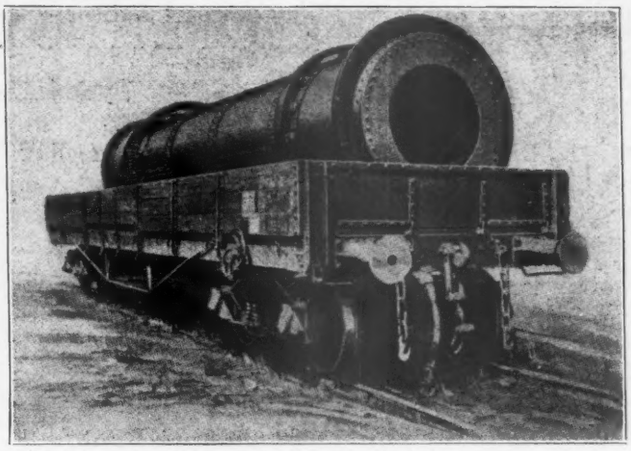
It carries removable panels. These are interchangeable and are erected upon the framework by means of clamps. They may be fastened or unfastened instantaneously. The bolted lime is carried by an elevator (20) by means of the screw (21),

1. To the reserve hopper (10).
2. To a sacking machine directly for the light lime by means of the screw (22).

The reserve hopper carries in its lower part the same regulator as that of the slag hopper. The lime charger (23) is equipped with parallel screws turning in different directions and bound by a detention box which keeps back the refuse caused by crumbling and by spaces which occur in the reserve hopper. The charger is like the slag one equipped with an arrangement allowing the number of speeds necessary for the different charges of the mixtures. The addition and coloring hoppers (12) are equipped with sliding doors and with regulators (24-25) of the same plan but in reduced size. The products, exactly measured, fall into a collecting screw conveyor with ordinary turns (26), which feeds the elevator distributing to the compound crushing mill.

Compound Crushing Mill (28)

This is built in very rigid style with a collar having large joint covers and made entirely of cast steel. The device turns between two supporting bearings of very great size. The first compartment is lined with silex and is loaded with sea pebbles. The second compartment is separated from the first by a grating of special steel which is easily removed. It is lined with blocks of white metal castings and is loaded with cylags (small rods of white metal castings). The outlet of this compartment is made across a similar grating, one like that of the first compartment and the product is taken by collecting machinery of appropriate shape which thrusts it out through the center of the axle.



Compound Crushing Tube

A revolving screen kept from the grinding parts is placed on the axle at the outlet. The feeding of the mill is made by a screw conveyor. It is equipped with a projecting stuffing box. It is erected upon the axle. The feeding of the mill is perfectly tight. The gear of the tube is reversible. The shaft pinion-carrier is made in such fashion that the replacing of the pinion can take place easily and very rapidly. The crushed cement falls into an elevator (29) which takes it to the silos.

The two cement silos are equipped in their lower region by plugs, which fit into revolving plug-holes (31). These are perfectly tight and are connected with the sacking machine by means of a detention box and by parallel screens similar to those of the lime chargers. The collecting screw of the bagging device feeds the automatic weights in a very orderly manner. This is a vital requirement for the obtaining of an exact weight. A special device for the return to the silo makes it possible to avoid the blocking that might result should the weights fail to work.

Supervision of the Operation

Samples are taken from the different parts of the machinery at regular intervals and the first materials as well as the finished products are immediately analyzed. This constant supervision of the manufacture makes it possible to obtain a very uniform product and therefore, a good reputation. The factory is equipped for the doubling of its production by the addition of a lime kiln and a compound crushing tube.

COMPETITION AND COSTS

By Edwin E. Dotter

NEARLY all lines of business are feeling the sharp pangs of competition, and the stone industry has not been an exception. In various sections competition has been very keen. The men who are responsible for the success of "big business," are watching the development of competition very closely, and those in charge of the smaller concerns, would, in many cases, be well repaid by doing likewise. Competition is narrowing the margin of profit, and success will go to those that can lower their costs. The marginal producers must receive a minimum profit, but a sound business concern is not a marginal producer. It is therefore necessary to cut costs below those of the marginal producers, if a concern wishes to get out of the marginal producer class, and successfully meet its competitors. A concern that is not in the marginal producers class is assured, not only of the marginal producer's minimum profit, but also the profit that results from the differences in their costs of production, known as a differential profit. Other things being equal, the differential profit goes to those concerns which have at their heads men of superior ability to formulate the policies and plans to be followed.

Undoubtedly many stone producers will say that they have already cut their costs to the very bone. But in reality have they? Perhaps they have, and if so they are to be complimented, and such concerns are no doubt enjoying their well earned differential profit. However, it seems that many quarries are still in a position where many economies could be effected. This is especially apt to be true with those concerns that operate only one quarry. In such cases it is oftentimes a "one man concern," who has his own particular way of doing everything pertaining to the quarry. Where several quarries are controlled by one company and all are subject to one centralized management, many economies can be effected which would not be possible to the smaller concerns, such as, savings in buying, selling and producing and perhaps the greatest benefit of all to the larger concerns is the practical knowledge and experience gained from the various plants.

In the stone industry as in other industries, "little business" would do well to study "big business," and its own business in trying to lower its cost of production. The superintendents who are directly in charge of the plants are in a position to effect many savings by using a little thought and study. It is their duty to stop the leaks, if possible, and to insist on a reasonable return on money invested in men and materials.

The human factor is the most important in the quarry. It is through them or because of them that costs can be noticeably increased or decreased. Men, to be fully efficient, must have the interest of the concern at heart. In the stone industry, where machinery plays a prominent part, it is absolutely essential that the man who is entrusted with the care and operation of a machine or machinery be thoroughly informed of the extra expense the company is called upon to suffer if the machine or machinery is not properly taken care of. If parts of the machinery become loose or out of adjustment or it is not properly lubricated, it should be and must be remedied at once or the resultant expense in the form of repairs or shut downs is very great. Instances might be cited by many superintendents and managers where just such unnecessary expenses have been incurred. Material expense in many industries should be carefully guarded. Is material discarded before it is really worn out? If the steam shovel engineer, the plant foreman, or the plant engineer orders new parts, should their word always be taken without question and parts ordered without first being certain that the parts are really needed? In many instances a checkup of men and materials may show some startling facts in regard to present expenses. It might not be out of place to add that an attempt at cost cutting should be done intelligently and not be carried to such an extent that the efficiency of the plant in either men or materials will be curtailed.

Lowering of costs is always worthy of the producer's consideration and in February issue of "System" we read the following: "The indications increase that 1927 is to be a good year for good management—the volume being available (unless local conditions or the position of the individual line involved happen to be unfavorable), but the actualities of obtaining it at a reasonable profit depending on good management because of the probable intensity of competition."

Midwest Division N. C. S. A. Elects

At the recent meeting of the Midwest Division of the National Crushed Stone Association in St. Louis at the Jefferson Hotel, officers for the year were elected. O. P. Chamberlain was elected president, and F. C. Murphy was elected secretary-treasurer. Messrs. Krause, Sanborn and Taylor were elected to the executive committee.

The subject of freight rates between slag, chats and crushed stone were discussed and a committee appointed to investigate the situation. The question of standard screens for agricultural limestone was also discussed and Mr. Sanborn was delegated to investigate the subject.

A SIMPLE PRACTICAL BUDGET PLAN

By R. N. Van Winkle

WHILE the New Year is after all a state of mind, we arbitrarily set the beginning of a year as January first and start anew, take a brace and new hope. Quite often we have failed to accomplish all we wanted and expected to last year and always we hope to do better the coming year, so with this new hope and the interest and opportunity the coming year offers us, we should be looking around for new ways, means and ideas to make our hopes come true, take advantage of every opportunity and awaken new interest in our own business affairs. If the writer were asked to name one thing that would be of the greatest benefit to the average quarryman at the beginning of a new year and a new operating season, my reply would be a Budget; a Budget System under which to operate your entire business from operations to sales, office expense and overhead included. Many of you may already be using a Budget Plan or System while others may possibly think a Budget of any sort is not applicable to quarry or open pit mining operation. If Budgets are a good thing for National or State Governments, Railroads, cities and personal household expenses, and are successful, why not in our business? The writer is absolutely sold on Budget Plan or System for our industry, not from what I have read or learned about it from heresay, but from actually working one up and having it in actual use for the last six months of 1926.

We are all too easy, we might term it, in telling our money where to go and never finding out where it actually went until it is quite often too late. Haphazard spending causes much waste and no end of worry and even embarrassment, and no business regardless of how small will eventually get on the right side of the ledger without a well balanced and seriously thought-out plan for spending money. You may say you are accomplishing this without the bother of a Budget. If you think you are, you are confusing the Budget with your accounts of income and expenditures and most likely basing your expenditures on your income. This is not Budgeting or a Budget, as a Budget is a definite plan worked out in advance estimating the necessary expenditures, based on past experience, necessary to carry on your business for three, six, nine or twelve months, as you may elect, irrespective of income.

In a recent article the writer stated that, "The wise executive will spare no time, according to the writer's theory, in establishing an Accounting System to keep track of earnings and expenses; to make a record of the operation." I am still a staunch believer in that statement but will recommend one step or measure, and that is the establishing and strictly adhering to a Budget. It is a very satisfactory, helpful and important thing to know definitely where your expenditures actually go and for the executive to have at his finger tips figures and data to fairly accurately ascertain what his actual money requirement will be next month or six months from date. The writer has possibly a too old fashioned or maybe odd idea of business and corporations or company. When it comes to expenditures in business, to him they are the same as personal expenditures. The truly successful business man does not buy a suit of clothes, a new radio or a new automobile for his personal use until he is quite positive he can pay for them, and generally pays cash. In purchasing life insurance he looks ahead to see if he can promptly and satisfactorily make the payments when due, or in other words, to use an old expression, he cuts his cloth to fit his conditions. These things are not always done in business and quite often we count our chickens, as they say, before they are hatched, by basing future expenditures and obligating ourselves to these future expenditures based on expected or future income. In this method we sometimes get rather a warped or twisted idea of our anticipated or future income, thinking we are going to be more prosperous than we really find ourselves to be and having purchased or expended when things looked so rosy, without being governed by actual necessities, we find ourselves out on a limb, so to speak. The successful business man and executive, even the superintendent, and the writer will go so far as to include the steam shovel engineer, has a pretty good idea of his personal expenses at home three, six or twelve months in advance and governs himself, if he is a good business man, accordingly, but these same men we fear would have a rather hard time estimating the plant or quarry payroll of the plant with which they were connected, two months ahead.

While the writer appreciates it has no particular bearing on this article it is nevertheless interesting to know what part of the average American family dollar goes for certain items of expense. On very good authority the writer has learned that 2 cents goes for railroad fare, 1.26 cents for telephones, 1.08 cents for gas, .21 cents for water, .42 cent for street car fare and 1.3 cents for electricity out of every family dollar. In the quarry and open pit mining industry, there are also certain percentages or certain parts of every dollar that can consistently be spent for certain things such as labor, electric power, fuel, repairs, etc. When these percentages or parts of the dollar exceed certain limits, which are fairly accurately defined, trouble will re-

sult as expenditures will be out of proportion to work or results accomplished.

It is no more difficult to Budget a quarry or open pit mining operation than it is any other business enterprise. There is nothing intricate or mysterious in the least about it as it requires only a little thought in planning and a close watch on details to make sure all and every item calling for an expenditure of money is entered, for a budget with items of expenditure omitted would be grossly misleading and nothing but pure guess or possibly worse. Personally the writer is a firm believer in simplicity, not alone in budgets, but in cost systems, inventories and all branches of records, files and reports in the handling of quarry business. A simple form of budget can be worked up by any interested executive or competent bookkeeper and this form will serve the intents and purposes well if not better than an elaborate form suggested and worked out by some accountant or accounting expert. There are so many methods of cost accounting, perpetual inventories, budgets, reports and such, used in other branches of industry that would be profitable and helpful in our industry, but they are as a rule so complicated and require so much additional clerical or office help that to quarries and open pit mining companies, aside from a limited few who are big enough, are prohibitive due to this one fact. So to avail ourselves of these things we must of necessity simplify them sufficiently to warrant attempting using them at all.

While executives or owners may have varied opinions of the form in which their particular budget is to be gotten up, a very simple form giving about all that the average executive or owner would really want is submitted here. This may not have as many items or be divided under as many headings as you might desire but the figures which are necessary in this particular form are easily and readily obtainable from the average set of books without additional clerical help. Bear in mind it can be as elaborate with as many divisions as you wish, but keep in mind too, after the original budget is once made, your books must be set up to ascertain each month the actual expenditure against each item listed for the purposes of checking back against the original budget figures for that month, so that you will be able to know whether you are over or under running the budget and to enable you to know without question of doubt that your money is going where you want it to go.

For convenience this form is divided into two major headings, Operating Charges and Fixed Charges. Under the first heading are grouped items which fluctuate more or less, while under the second heading are items which are more or less permanent for 3, 6, 9 or 12 months at a time at least. You may question how amounts of labor and such items are arrived at. These are obtained from the tonnage you expect to produce during the particular month. All who are engaged in the quarry and open pit mining business make a forecast, the writer feels, based on past history of the operation and future prospects as to what tonnage we expect to produce each month during the operating season and if we don't we are poorer business men than expected. Tonnage monthly is the source for supplying figures for items under heading No. 1, and actual book figures are used in supplying the figures for items under heading No. 2.

It is an extremely simple thing to make up when once you put your mind to do it. Do not, however, guess at the figures to put down, but do your best to calculate each item as best you can and eliminate all questions of doubt in so far as it is humanly possible, give the figures serious consideration and use ample time to arrive at your conclusions, avoiding all elements of being mistaken—be 100 per cent right if you can.

Now after the budget is made just what can it do for the operator and wherein can it help the executive or owners? First of all it has given already an insight into your business which the

SIMPLE BUDGET FORM FOR QUARRY OPERATION

Item	January	February	May	June	November	December
OPERATING CHARGES						
Labor Payroll						
Office Payroll						
Sales Salaries and Expense						
Office Supplies (Tel., Tel. & Stamps)						
Coal						
Electric Power						
Explosives						
Plant Supplies and Repairs						
Freight Supplies and Repairs						
Compensation and Liability Insurance						
TOTAL						
FIXED CHARGES						
Taxes						
Fire Insurance						
Interest on Borrowed Money						
Depreciation						
Depletion						
Sinking Fund						
TOTAL						
GRAND TOTAL						

writer questions you had before—you have something absolutely tangible, fact, figures at your finger ends which it is questionable if you had before in such logical form. You, moreover, have gone on record for 3, 6, 9 or 12 months as the case may be as to just what amounts of money are necessary, as far as your best judgment is concerned, to spend for each item listed. You, moreover, have your organization, superintendent, master mechanic, sales organization, office force and in fact every branch of your business on record as far as their experience and best judgment is concerned as to the amount of money necessary to carry on their branch as you have of necessity canvassed their requirements and embodied them in your budget figures. With yourself and your official staff or family on record you are going to be surprised at the increased interest your organization will take and means they will employ to be under the budget figures at the end of the month. It's a sort of a game of chance and the sporting element inbred in the average man will assert itself and in the right direction.

A budget will automatically make the spending of money a real part of your business, and economy the watchword. It might be interesting to know in this connection that 85 per cent of the reduced operating expenses of railroads in the United States in 1925, as compared with 1920 was traceable and effected through a system of rigid and intelligent economy. A budget system in a quarry or open pit mining operation, if intelligently installed, watched and rigidly enforced, will not permit waste and every foreman or head of a department can be held responsible for his expected share of accomplishment.

If an executive or owner needs financial help from a bank your budget will tell you just how much help you need and when and if you see fit to lay your Budget down before your banker and show him you know precisely what you are after and that you are running your business in a business like way and not by guess, or the old rule of thumb, it will unquestionably assist you in gaining your loan and better your financial standing with him.

Spending money is as important as making money. Take a big department store for instance; their buyers receive larger salaries than their salesmen. Give that a minutes consideration. Is it a new thought? Some of us in the quarry and open mining industry can effect bigger profits in spending judiciously than we can in selling at an increased price our product and a Budget will help show you the way.

Budgeting not only applies to operating but to office and sales organization as well, and as the quarry and open pit mining industry is becoming more competitive every day, the handling or running of a pit or quarry is not a pastime for millionaires or monied people, but it is a real business enterprise calling for the practice of economies and thrift in every form. While it may not be so true in this industry as it is in many others of today, way by far too much money is spent or I'll venture to say wasted in sales expenses. We are too apt to use only the superficial aspects of our fellows—the clothes they wear, the automobile they drive, the things they show and the way they live, and attempt to copy them and live and spend as far as company matters are concerned too extravagantly in our desire to keep on a par or outdo our fellows. Mature observers readily know this is not thrift or economy and will, therefore, be short lived in most instances. These extravagant ideas can be curbed by budgeting sales salaries and expenses and the minute expenditures overrun the budget figures, your attention is immediately called to the situation and proper and drastic measures, if necessary, can be applied.

The budgeting of labor, the most costly thing in our business and industry, is most important. Labor hours are money. Labor wasted or inefficient labor, is dollars and cents wasted. The right sort of an executive today is loaded down with detail, not alone details of the business in general, but the seeming carelessness, mistakes and indifference of the average fellow who is employed. The writer believes that the larger proportion of working men today have lost or never had any conception of what is meant by rendering service in return for the wages they are paid, while the executive has no hours, or if he does, they are generally limited only by the limit of physical or mental endurance.

One of the world's most famous questions today is "How Much Does It Cost." This question is heard on every hand in most every walk of life and in every business. A properly worked up budget in our particular line of business will answer this question as far as our business is concerned. It will give figures and data as to the cost of sales, repairs, fuel and in fact every item or division that is budgeted. Figures today are meaning more and are exerting a greater influence on the managing of business. Figures mean more than salesmanship. Figures will often prove whether you are right or wrong in your deductions, and when in doubt as to a matter of importance, figures will quite often decide the matter very quickly. By way of illustrating the question of figures deciding a matter:—Too often major repairs to machinery or buildings and even additions to plant are made without beforehand ascertaining an estimate of cost. Work proceeds as the repairs or additions appear to be necessary and we assume by using our regular force of men during odd times the cost will be small, while as the case generally turns out the cost is great and about 50 per cent above our

expectations, but it's too late then; the job is done and the money spent. If figures had been worked up beforehand on the cost of these repairs or additions, and worked up accurately, the cost of the repairs or additions would have shown it was prohibitive as far as cost was concerned and money would have been saved or another method of repair or addition not so costly would possibly have been followed. As a rule there is more than one way to do a thing and figures very often show the best way.

A Budget in its original form, even in our business, should show the amount of money or appropriation desired for every branch or division of our business, sales, repairs, new buildings, labor, etc., or in fact every item requiring an expenditure. The original budget should then be pared down or built up, which is seldom necessary by the executive, directors or owners who are in a better position to know just what the financial condition of the operation is and who really must cut the cloth to fit the condition. Right here is where a good executive, director or owner really shines, as the writer believes it is easier to save a dollar than sometimes make a dollar, and a well worked up, intelligent budget is the greatest dollar saver he knows of right now.

Our own National Government has in the last six years, since 1920, if my information is correct, saved six billion dollars traceable directly to the budget system. These figures may not be absolutely correct but the saving has been tremendous. It was made possible by budgeting the expenses of our National Government in advance of spending and while it is true the original budget often carried figures calling for expenditures for things not necessary, the budget was pared down and appropriations cut out, resulting in savings above our expectations even in a business as big as our National Government.

The establishing of a budget in the handling of a quarry or open pit mining business is applying just a new helpful idea to an old line business. It is a way to prove by figures and statistics whether adjustments in expenditures are needed and where. The factors upon which success depends in our business or in any modern business are varied enough to need careful thought and constant watching, yet they are not too numerous or too uncertain that they cannot be fairly accurately estimated and budgeted.

The writer in this article as well as in several others he has written can but only suggest ways, means and ideas of assisting the executive or operator and you must of necessity apply them to your own problem but the writer is a believer that we can all gain new wisdom from the experiences of others engaged in a like or kindred industry. The budget idea was new to the writer but after six months operating under it the experience has been satisfying as well as gratifying and if you have not considered it, try it by all means. Railroads in our country disburse for wages $320,000.00 every hour, and for fuel, material and supplies more than $42,000.00 hourly, and tnese enormous expenditures are handled by budget or appropriations, whichever you mind to call them, and so successfully that railroads are paying good dividends.

There are few, if any, of us quarry and open pit mining owners or operators that can talk or let alone think in figures so big—there are also very few, if any, of us who can have our pictures on bank notes, but with a well thought out practical budget system in vogue in our business, we can eventually be the owner of more of these bank notes and talk in bigger figures.

Savings Increase Billion and a Half

A billion-and-a-half dollar increase in America's savings in banks in a year, a growth of nearly three million in number of depositors and a new high per capita savings rate for the nation of $211 are disclosed in the annual compilation of the Savings Bank Division of the American Bankers' Association. The figures, made public by W. Espey Albig, in charge of the division, show that on June 30, 1926, there were for all classes of banks in the United States 46,762,240 savings depositors and $24,696,192,000 in savings deposits. The same date in 1925 there were 43,850,127 depositors and $23,134,052,000 savings deposits.

"The gain in the year ending June 30, 1926, of $1,562,140,000, which is approximately $400,000,000 less than the gain in savings during the preceding year and but one hundred million more than the savings gain for the year ending June 30, 1924, is thrown into stronger relief by the great increase in the number of savings depositors reported," said Mr. Albig in presenting the figures. "The number of depositors stands at 46,762,240, a gain of slightly less than three million. The mutual savings banks gained over 300,000 depositors, other state banks and trust companies over 1,800,000 and the national banks over 700,000. More than half a million of the gain in the number of depositors came from the increased number of depositors in school savings accounts.

"General and widespread prosperity in the United States during the past year caused this great increase in the number of depositors, although in the United States generally the gain in the amount of savings has been less per inhabitant for the year ending June 30, 1926, than during the preceding one. This is not true, however, in the case of every state. New Hampshire, Maine, Connecticut, Delaware, West Virginia, Louisiana, Tennessee, Indiana, Illinois, Wisconsin, Wyoming, Idaho, and Nevada made larger gains per inhabitant than during the preceding year."

PRODUCTION OF SULFUROUS ACID FROM GYPSUM

By Prof. Bernhard Neuman
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THE production of sulfuric acid from gypsum, anhydrite, magnesium sulfate, etc., is a problem which had to be taken up very seriously during the War as the obtaining of pyrites was rendered extremely difficult. To utilize the sulfur of the gypsum or of the anhydrite which are available in large quantites in Germany there are two fundamentally distinct methods. One is the direct double decomposition of the calcium sulfate with other salts to give certain sulfates which can be used in technology as such or which can be decomposed afterwards. The most important decomposition of this type is that of gypsum by ammonium carbonate to convert synthetic ammonia into commercial ammonium sulfate:

$$CaSO_4+NH_3+CO_2+H_2O=CaCO_3+(NH_4)\,2SO_4,$$

is being utilized on the largest scale by the Badische Anilin und Soda Fabrik. The other large group of processes to obtain sulfur or sulfur dioxide from gypsum is based on the fact that calcium sulfate on heating, preferably with the addition of other substances, is decomposed in accordance with the equation:

$$CaSO_4 = CaO + SO_3;\ 2SO_3 = 2SO_2 + O_2$$

A variety of this class includes those processes which depend on a preliminary reduction with carbon to calcium sulfide which is then converted in various ways to sulfur or sulfur dioxide. The direct decomposition of gypsum by dissociation requires such elevated temperatures that it proves uneconomical in practice. Numerous processes therefore attempt to displace the breaking off of sulfur trioxide (or sulfur dioxide and oxygen) toward lower temperature regions by the addition of silica, clay, iron oxide, etc., which enter into reaction with the gypsum. In certain respects the action of generator gas and coal on gypsum belongs in this class.

Attempts to utilize sulfate were not caused for the first time by the economic necessities of the War, but go back to the middle of the previous century. During the War several of these processes were utilized on a large scale but most of them have not retained any permanent success. Thus the plants at Bernburg and Walbeck which reduced gypsum by means of coal in a rotary kiln to calcium sulfide from which hydrogen sulfide was displaced by magnesium chloride solutions, the hydrogen sulfide being converted to molecular sulfur in a Claus furnace have been shut down. Similarly the plant at Neckarzimmern where a mixture of gypsum and coal in a shaft furnace was blown with air to react according to the equation:

$$CaSO_4 = CaO + SO_2 + O;\ SO_2 + 2CO = S + 2CO_2$$

to yield sulfur, has been given up. Also the direct decomposition of gypsum into $CaO + SO_2$ by heating with generator gas in a shaft furnace which was tried out for a time at Waldhof could not survive, nor could the treatment of anhydrite with coke in a rotary grate generator as tried at Duisburg.

Permanent success was obtained only by the gypsum-sulfuric acid process with simultaneous cement production as carried out by the Farbenfabriken vorm. Fr. Bayer & Company. W. J. Müller reported on this process in this journal earlier in the year. It consists in principle of burning a finely ground and screened mixture of anhydrite or gypsum with argillite and coke to clinker in a rotary tube furnace, and then working up this clinker with slag sand to a blast furnace cement, so that a good cement is obtained as well as sulfur dioxide. In this case the large amount of heat used in the reaction.

$$CaSO_4 = CaO + SO_2 + O - 116.36\ Cal$$

is divided between two valuable products which is not the case in the previously proposed processes.

Of the older processes Müller in the above-mentioned article named quite a few to which we need only refer here. To complete the list the following may be mentioned. The Lonza Electrical Works (Swiss Patent 72,627) add quartz to the gypsum and carry out the reaction in an oxygen-enriched atmosphere in which it is claimed sulfur trioxide does not dissociate.

German patents 305,152, 307,101, 307,043, 371,863, 371,864 and 372,833 of the Metallbank claim to obtain sulfur dioxide from gypsum by blowing a mixture of sulfate and fuel with air in a Huntington-Heberlein Converter or in a Dwight-Lloyd Sintering Furnace, preferably with the addition of certain fluxes like silica, iron oxide, alumina, etc. According to Bambach (German Patent 304,382) the sulfates in a shaft furnace are decomposed by the flameless combustion of a gas-air mixture with the reaction mass.

The B. A. S. F. according to German Patent 306,313 introduces the finely divided sulfate with the fuel into a long, oxidizing flame. German Patent 352,125 of the Rhenania adds pyrites and iron oxide to the gypsum. Compare German patents 372,715, 375,872, 380,025, 386,295, 391,602, 391,603, 394,362, 417,410, 417,441. Trautz according to German Patents 356,414 and 375,657 heats anhydrite with carbon or iron turnings in a stream of inert gas or (in German Patent 377,409) the dehydrated gypsum with the sulfides of iron, lead,

*From Zeitschrift fur angewandte Chemie, Dec. 16, 1926.

zinc. Harnist, German Patent 380,999, reduces calcium sulfate to sulfite with carbon. Jannasch and Alberts, German Patent 318,221, calcine gypsum with additions like quartz in a stream of carbon tetrachloride vapor.

The Association of Chemical Factories Mannheim (English Patent 149,662 of 1921 and Swiss Patents 94,448, 95,454, 95,612) add iron, iron oxide or carbon and then heat to 900°C. while blowing in steam and air. According to German Patent 301,-712 Weeren treats gypsum with reducing agents and siliceous materials in a shaft furnace. Weilerter-Meer, German Patent 307,722, attempts to decompose the gypsum at a temperature of above 1000°C. by the addition of 12-15 per cent calcium sulfide; according to German Patent the addition of 4-5 per cent of coke causes the intermediate formation of CaS. The cement patents of the Farbenfabriken vorm. Fr. Bayer & Company for the "Preparation of Sulfuric Acid and Hydraulic Cements" are German Patents 297,922, 299,033, 310,070 and the principal patent 388,849.

The patents had a predecessor. Basset, German Patent 324,570, had already in 1912 protected a process "For the Production of Cement or Hydraulic Lime by Heating Gypsum or Anhydrite together with Alumina and Obtaining Sulfur Dioxide, Characterized by the Fact that an Intimate Mixture of Calcium Sulfate, Alumina and Carbon Is Calcined in the Presence of Steam." According to Addition Patent 326,216 gypsum and alumina are first heated and the resultant calcium silico-aluminate is mixed with slaked lime, some coal is added to form calcium sulfide which is supposed to interact with the calcium sulfate. The process was never commercialized.

If we review all the proposals made we find only a few which attempt to decompose the gypsum by heat alone; all the others attempt to make the decomposition easier by the addition of various materials. Amongst those proposed are quartz; alumina; carbon; alumina and carbon, pyrites and other metal sulfides; sand and pyrites; gypsum, sand and alkali sulfates. The idea in the last mentioned proposal is along the same lines as the cement patents, namely, to produce together with the sulfur dioxide a second valuable product, in this case glass.

The decomposition of gypsum with CaS, exactly speaking, does not belong amongst the processes for the direct decomposition of gypsum, but we shall return to this reaction later. At what temperatures the decomposition of pure calcium sulfate occurs, or the expulsion of sulfur trioxide by silicic acid, alumina, iron oxide, etc. occurs, is not supported by reliable data in the patent literature. Nevertheless considerable is known about this.

First we have the dissociation relationships: $CaSO_4 \rightarrow CaO + SO_2 + O$. These were studied by von Hofmann and Mostowitsch (Transactions Amer. Inst. Min. Engineers, vol. 39, page 625, 1910) in their investigations on the phenomena of the roasting of lead ores. They found that the dissociation of pure calcium sulfate first begins at 1200 degrees C. This decomposition temperature is lowered to 1100 degrees C. by addition of iron oxide, and to 1000 degrees C. by addition of silica. The decomposition of calcium sulfate is complete at 1200 degrees C. in the presence of silica or iron oxide. Pure calcium sulfate, on the other hand, begins to fuse at 1360 degrees C. and the melt consists of varying proportions of $CaSO_4$ and CaO and complete decomposition is not attained at this temperature. The attached table gives a résumé of the experimental data for a heating period of 10 minutes. The degree of decomposition is given in per cent, that is, the loss in SO_3 compared to the total content of SO_3.

Time of Heating	Temp. °C.	$CaSO_4$	$3CaSO_4 SiO_2 CaSiO_4$	$CaSO_4 SiO_2 CaSiO_4$	$CaSO_4 SiO_2 CaSiO_3$	$2CSO_4 3SiO_2 Ca_2Si_3O_8$	$CaSO_4 CaFe_2O_4 Fe_3O_3$
10	1000	....	0.46	0.71	0.47	0.46	....
10	1100	....	1.84	3.27	3.51	7.40	0.36
10	1150	....	3.43	6.13	6.92	....	2.26
10	1200	0.35	7.77	12.78	12.50	24.66	8.27
10	1250	1.81	12.12	22.64	34.99	44.76	31.37
10	1300	4.38	....	....	....	....	95.36
10	1360	17.80	....	....	....	....	....
10	1400	36.45	....	....	....	....	....

If we consider these figures we find such small degrees of decomposition that they do not seem to agree with previous data. But we must not overlook the fact that the above table gives merely the decomposition for the first 10 minutes while complete decomposition of the gypsum with silica or iron oxide is reached only after a long period of heating.

The same authors later studied also the reduction of calcium sulfate by carbon monoxide and carbon as well as the oxidation of calcium sulfide (Trans. Am. Inst. Min. Eng. vol. 39, page 917, 1910). The reduction of the sulfate to sulfide by carbon monoxide begins at 680-700 degrees C., is most rapid between 750 and 850 degrees C. and is quantitatively complete at 900 degrees C. The reduction with solid carbon begins at 700 degrees C., proceeds vigorously between 700 and 900 degrees C. and is complete at 1000 degrees C.

Budnikoff & Syrkin (Chem. Ztg., 1923, page 22) have determined the dissociation temperature of pure calcium sulfate (pure gypsum from Kahlbaum dehydrated at 450 degrees C.) at atmospheric pressure. They heated 1 gram of gypsum for 3 hours at various temperatures. They found different data than those of Hofmann and Mostowitsch. The decomposition proceeded as follows:

Time of Heating in Hours	Temp. ° C.	Per cent Loss in Weight	Per cent Dissociation	Composition of Residue % $CaSO_4$	% CaO
3	800	0.14	0.33	99.91	0.09
3	900	0.27	0.45	99.81	0.19
3	1000	0.30	0.51	99.79	0.21
3	1100	1.60	2.71	98.86	1.14
3	1200	2.30	3.91	98.35	1.65
3	1300	4.10	6.97	97.00	3.00
3	1375	58.50	99.46	1.33	98.67

According to this the dissociation begins at 800 degrees C. but remains very slight and reaches only 3.91 per cent at 1200 degrees C., and only above 1300 degrees C. does fusion of the mass occur with complete decomposition. Marchal (J. chim. Phys. vol. 23, page 38, 1926) approached the problem from a different point of view and determined the decomposition of the gypsum by measuring the vapor pressure of the calcium sulfate and the mixtures produced from it. According to his investigations calcium sulfate dissociates appreciably above 960 degrees C. The total sulfate dissociates appreciably above 960 degrees C. The total vapor pressure is:

Temperature	1000°	1100°C.	1200°C.	1230°C.
Pressure	8 mm.	24.1 mm.	67.7 mm.	98.0 mm.

Addition of silica (added amorphous or as powdered quartz), of alumina, kaolin or ferric oxide accelerates the decomposition. In mixtures of 1 mole of $CaSO_4$ with 1 mole of SiO_2 or Al_2O_3 or Fe_2O_3 as well as with a mixture of 10.2 $CaSO_4$ to 5.6 kaolin, the following total pressures were observed:

Addition	Temp. Pressure	940°C. mm.	1000°C. mm.	1100°C. mm.	1170°C. mm.	1240°C. mm.	1250°C. mm.	1280°C. mm.
SiO_2	....	10.5	20	94	219	...	575	817
Al_2O_3	....	....	9	25	50	...	133	200
Kaolin	....	75.0	173	589	1070	...	...	...
Fe_2O_3	....	....	12.5	37	90	178	...	273

The ease with which kaolin reacts with calcium sulfate compared to the reaction of its components SiO_2 and Al_2O_3 is noteworthy. Chromium oxide proved to be ineffectual. In another place (Compt. rend. vol. 177, page 1300, 1924) Marchal has calculated the temperatures at which the pressures reach 760 mm. exactly. He finds for

$CaSo_4 + SiO_2 = CaSiO_3 + SO_2 + O$ 1273°C.

$CaSO_4 + Al_2O_3 = Ca(AlO_2)_2 + SO_2 + O$ 1363°C.

For a mixture of gypsum and kaolin a pressure of 760 mm. must have been reached at about 1130 degrees C. according to the above table. The temperature was not determined for pure calcium sulfate, but we may caluculate approximately that the pressure must reach 760 mm. at about 1400 degrees C. which agrees with the calculations of Budnikoff and Syrkin.

The action of clay on gypsum was studied also by Kramm (Sprechsaal 1912, no. 25) although for ceramic purposes only; he made mixtures of alabaster and slurried China clay and determined the losses at burning temperatures of 900-1350 degrees C. His figures are not directly applicable to our purposes, as the loss figures include the water lost by the clay molecule which varies for different temperatures. Such curves for loss of water by kaolin and various clays were recently published by B. Neumann and S. Kober (Sprechsaal Sept. 15, 1926). However, other data by Kramm interest us for he determined by tests at 1100 degrees C. with varying proportions of gypsum and kaolin that at 1100 degrees C. all the sulfuric acid can be driven off if the burning time is long enough, and that this does not occur at 950 degrees C. even with 40 hours burning. This figure checks well with the Marchal's pressure measurements.

Also the action of metallic sulfides (and silicic acid) on gypsum are represented by data in the literature. Schuetz (Metallurgie, 1909, page 226) investigated the action of PbS, Cu_2S, and ZnS in the presence of SiO_2 on gypsum in his study of the reactions of blast-roasting processes (Carmichael-Bradford Process). The individual figures need not be repeated here. Schuetz concludes "that the decomposition of calcium sulfate under the influence of silicic acid and metallic sulfides begins at temperatures below 800 degrees C. The decomposition of calcium sulfate is practically complete at 1000-1100 degrees C." From his experimental data a somewhat higher temperature is indicated, but the degree of silicating plays a role as larger additions of silica accelerate the decomposition.

From the previous consideration it appears that the temperatures required to decompose gypsum into CaO and SO_3 are very high even when additions accelerate the release of the sulfur trioxide. The consumption of fuel, irrespective of other technical difficulties, is the chief hindrance to the economic development of the recovery of sulfurous acid from gypsum. In the following pages a new proposal will be made according to which the decomposition of gypsum is brought about, so as to say, without the use of any external fuel.

From our blast furnaces there flows annually a stream of millions of tons of slag with a temperature of 1300-1600 degrees C. The quantity of slag varies for different blast furnaces; on the average it amounts to 110 per cent of the weight of pig-iron; for foundry, Bessemer, and Thomas iron it is 70-80 per cent; a Rhenish 250 ton blast furnace produces roughly 200 tons of slag per day. The heat content of blast furnace slag on drawing, according to Ackermann and Bell (See Richards' "Metallurgical Caluculations"), amounts to 525 calories on the average. We lose at present immense quantities of heat in the slag. In blast furnace slag we have a source of heat energy without cost which, as we shall soon see, can be easily utilized for the decomposition of gypsum by dissociation.

I have made investigations along the following lines:

I. Synthetic Slags

A mixture was prepared from pure alumina, calcium oxide, and silica in the proportions given below for Upper Silesian blast furnace slag. For the tests 100 grams of these slag mixtures were melted in a graphite crucible in Meker furnace. After the slag had become fluid at 1350 degrees C. 12.35 grams of anhydrous gypsum were added, stirred and after definite times samples were taken. The amount of sulfur added with the 12.35 grams of $CoSO_4$ was 2.90 grams of S.

	Time of Heating Hours	Temperature °C.	Sulfur remaining in 100 grams of slag (grams)	Sulfur eliminated in % of total introduced.
A	½	1350	0.261	91.7
	½	1400	0.146	95.0
B	¼	1450	0.282	90.3
	¼	1460	0.210	92.8
	¼	1460	0.182	93.7
	¼	1460	0.147	95.0
	¼	1460	0.147	95.0

II. Blast Furnace Slags

The blast furnace slag used was an Upper Silesian high sulphur slag of the following composition: 38.42 per cent SiO_2, 32.28 per cent Al_2O_3, 2.14 per cent Fe_2O_3, 26.24 per cent CaO, 1.28 per cent MnO, 1.21 per cent total S, of which 0.97 per cent was sulfide S and 0.24 per cent sulfate S. The finely powdered slag was melted as described above; at 1280 degrees C. it began to be fluid. At 1300 degrees C. 11.34 grams of anhydrous calcium sulfate were added, stirred and heated again. In this experiment note was made of the CaS content of the slag in the expectation that this would react according to the equation:

$$CaS + 3CaSO_4 = 4CaO + 4SO_2$$

The CaS present would require 12.36 grams of $CaSO_4$, but as 0.24 per cent sulfate sulfur (equivalent to 1.02 grams $CaSO_4$) was already present only 11.34 grams of $CaSO_4$ were added. The slag contained a total of 3.96 grams of sulfur, 0.97 as sulfide, 0.24 as sulfate and 2.75 added by the gypsum.

	Time of Heating Hours Hours	Temperature °C. °C.	Grams Sulfur remaining in 100 grams slag (grams)	Sulfur eliminated as % of total present introduced
A	½	1300	0.876	77.9
	½	1350	0.652	85.8
	slag heated to 1400° C. addition made as before			
B	¼	1480	0.395	90.0
	¼	1460	0.370	90.7
	¼	1450	0.353	91.1
	¼	1460	0.358	91.1
	¼	1470	0.339	91.4

The experiments with the synthetic slag and the blast furnace slag show very clearly that the decomposition of gypsum or anhydrite by dissociation using the heat of the slag is very rapid and complete. In the one-quarter hour more than 90 per cent of the gypsum is decomposed. Better feeding and stirring devices will tend to make the decomposition more complete. Longer heating improves the yield very little. At temperatures below 1400 degrees C. the conversion is poorer. It should be noted that in the second series with sulfide slags after the decomposition of the calcium sulfate the slags still contained calcium sulfide; the incompleteness of yield is not chargeable to the gypsum decomposition but to the incompleteness of the reaction of CaS with CaO_4.

The experiments with synthetic sulfur-free slags in which we have only the dissociation of $CaSO_4$ to consider give much the better results. These experiments show that all types of blast furnace slags are suitable for decomposing gypsum and not only the low sulfur slags on which the Diehl process to be described later is based.

The practical application of the above process of decomposing anhydrite would be about as follows. The hot slag is tapped from the blast furnace into a canal shaped closed iron container lined with refractory material; the cover would be removable so that solidified crusts could be dislodged; the cover at the inlet end is provided with a screw-feed for the introduction and stirring of the anhydrite, and with a drawoff flue for sulfurous acid at the exit end.

A rough thermal calculation shows what may be expected from the proposed process. 1 kg. of anhydrite requires 692 calories to decompose it into CaO and SO_3. 10 kg. of slag at 150 degrees C. have a heat content of 5250 calories; the heating and dissociation of the anhydrite consumes about 1000 calories; if we add 1 kg. anhydrite to 10 kg. of slag the temperature of the slag would have to drop to 1000 degrees C. (as its specific heat is about one-quarter) at which temperature it would freeze if no external heat is added. If we add only one-half kg. of anhydrite to 10 kg. of slag the temperature of the slag would drop to only about 1200 degrees C. In many cases especially with higher initial slag temperatures this amount of anhydrite could be added. It would be more economical in all cases to heat the box externally with blast furnace gas. In every blast furnace gases with a thermal value of 800-900 calories per cubic meter are available for outside use to the extent of 25-40 per cent of the total produced. For each ton of pig iron produced we obtain about 4500 cubic meters of gas of which at least 1100-1500 cubic meters are excess. In a 250 ton blast furnace we have 275,000-375,000 cubic meters of excess gas available. 10 kg. of slag require to bring them to their original temperature 1250 or 630 calories, or 1½-⅔ of a cubic meter of blast furnace gas. Heating with 1 cubic meter of gas makes it possible to heat 0.5 kg. of anhydrite more than is possible without the use of gas. A Rhenish 250 ton furnace producing 200 tons of slag per day, could thus decompose 20 tons of anhydrite if external heating of the slag tank is provided for; this external heating would require 20,000 cubic meters of blast furnace gas or only

a fifteenth of the excess gas produced. These 20 tons of anhydrite correspond to 4.7 tons of sulfur or about 14 tons of sulfuric acid.

The slag flowing from the slag tank is several per cent higher in lime and is better suited for the manufacture of Portland cement than before; in fact certain varieties will be made available for cement manufacture by this treatment. This proposal for the utilization of the heat of slags for decomposing gypsum and anhydrite has nothing in common with other proposals to utilize blast furnace slags but for entirely different purposes.

German patent 349739 of the Metallbank claims to obtain sulfur dioxide from calcium sulfide, by first converting calcium sulfate to sulfide and then "dissolving it (or mixing) with a fused slag, and blowing air into this solution (or mixture)." In this case calcium sulfide is caused to react with calcium sulfate in the slag.

On the other hand Diehl attempts to utilize the calcium sulfide which is present in every blast furnace slag as a source of sulfur; his process requires the slags richest in sulfur. The sulfur content of blast furnace slags in general varies between 1 and 2 per cent, and higher sulfur contents appear only on improper functioning of the blast furnace such as the so-called "sulfur misery"; a slag with 1.5-2 per cent of sulfur is a "high sulfur" slag. Diehl's first proposal (German patent 299151) "to utilize the sulfur contained in blast furnace slag" proceeded "to convert the sulfide sulfur present in the liquid slag to sulfuric acid by oxidation with a current of air." According to a second patent of Diehl's (German patent 301613) "the sulfur contained in the fluid slag is converted to sulfuric acid by oxidation with suitable chemical compounds such as calcium sufate," or "a quantity of sulfate insufficient to completely oxidize the sulfur present is introduced and the oxidation is aided by blowing in heated air." German patent 304381 describes the installation for the carrying out of the process. Diehl's process was tested for a time at the Gute-Hoffnungs plant. Diehl reported on this in Stahl und Eisen, vol. 41, page 845, 1921. A slag tank 3.5 meters long, 0.6 meters broad and 1.4 meters deep was used into which air was blown laterally. In 24 hours 180-240 tons of slag passed through this tank. From the results reported we can see the following. On oxidizing with air alone, good warm Thomas pig iron slag decreased in sulfur content from 1.50 per cent to only 0.98 per cent (average of 17 runs). Thus only 33 per cent of the sulfur was oxidized to sulfuric acid. On treating the slag with anhydrite and air there was added (average of 12 runs) to the slag with 1.66 per cent sulfur 0.75 per cent of anhydrite; after the blow the sulfur content of the slag run off averaged 1.09 per cent; of the 1.84 per cent total sulfur present only 75 per cent (40.7 per cent of the total) was removed as sulfur dioxide. The elimination was thus poor. We shall now investigate the cause for this failure. Diehl considers the reactions to be:

$$CaS + O + CaSiO_3 = Ca_2SiO_4 + S;\ S + O_2 = SO_2$$
$$CaS + 3CaSO_4 + 4CaSiO_3 = 4Ca_2SiO_4 + 4SO_2$$

The calcium silicate has really nothing to do with the oxidation of the calcium sulfide, the actual reactions being

$$CaS + O = CaO + S;\ S + O_2 = SO_2$$
$$CaS + 3CaSO_4 = 4CaO + 4SO_2$$

We carried out through Engineer Koester several researches on these reactions some time ago. Of these researches the following brief account will be given. The tests were made in a quartz tube which was brought to the desired temperature by an electrically heated resistance furnace. The material was placed in a porcelain boat after the tube had reached the desired temperature; then it was heated two hours. Dried air carried off the sulfur oxide evolved to washing bottles containing sodium carbonate solution; in this solution the sulfur was determined as barium sulfate. The calcium sulfide used had the following composition: 42.93 per cent sulfide sulfur (instead of 44.44 per cent theoretical), 0.11 per cent sulfite sulfur and 0.06 per cent sulfate sulfur.

Dried Air on Calcium Sulfide

Temp. ° C.	Amount Used Grams	Sulfur Expelled Grams	%	Composition of Residue % CaS	% $CaSO_4$	% CaO
600	0.250	0.0013	1.2	93.1	1.7	4.9
800	0.250	0.0040	3.7	70.8	23.8	5.9
900	0.250	0.0146	13.6	33.5	57.6	8.6
1000	0.250	0.0285	26.5	15.9	68.0	15.8

It will be observed that in these tests the boat is always heavier after the experiment than before, the explanation for which is that a large part of the sulfide oxidizes to sulfate which is obvious also from the table for the composition of the residue. By air oxidation on heating for two hours at 1000 dgerees C. only 26.5 per cent of the sulfur could be expelled as sulfur dioxide.

A pair of similar tests were made by Hofman and Mostowitsch (Trans. Amer. Inst. Min. Eng. vol. 39, page 917, 1910). At 500 degrees C. the decomposition of the sulfide was detectable, at 800 degrees C. it became vigorous. Both tests are given in a table similar to the one above:

Temp. ° C.	Amount Used Grams	Sulfur Expelled Grams	%	Composition of Residue % CaS	% $CaSO_4$	% CaO
900-950	0.106	0.0159	33.85	trace	72.49	27.51
900-950	0.244	0.0329	30.41	0.45	75.03	24.52

In these two experiments after 1½-2 hours heating at below 1000 degrees C. all of the calcium sulfide was decomposed but only 32 per cent on the average was driven off as sulfur dioxide, while almost 74 per cent of the residues from the experiments consisted of calcium sulfate. As a result of

the action of air on calcium sulfide at best one-third of the sulfur is recoverable as sulfur dioxide while the other two-thirds remain bound as calcium sulfate.

Calcium Sulfide on Calcium Sulfate

The sulfur dioxide appearing in the above experiments can arise only as a result of the air oxidizing part of the calcium sulfide to calcium sulfate which in turn reacts with unchanged calcium sufide:

$$3CaSO_4 + CaS = 4CaO + 4SO_2$$

This reaction was more carefully examined both in the presence of air and in the absence of oxygen. A mixture was prepared containing 82.8 per cent $CaSO_4$, 15.63 per cent CaS and 1.6 per cent CaO; there was thus 1 per cent CaS in excess. The reaction time for the following experiments was one-half hour.

Effect of CaS on $CaSO_4$ in a Current of Air

Temp. °C.	Weight Used Grams	Sulfur Expelled Grams	Sulfur Expelled %	Composition of Residue % CaS	% $CaSO_4$	% CaO
800	0.250	0.0006	0.9	14.0	85.1	0.9
900	0.250	0.0014	2.1	5.8	92.5	1.7
1000	0.250	0.0064	9.7	....	93.7	2.3
1100	0.250	0.012	18.05	....	94.5	5.5

The table shows that using pure substances in a current of the air the conversion is no better than before and that even at 1100 degrees C. only 18 per cent of the sulfur is obtained as sulfur dioxide, but that the calcium sulfide disappears very quickly while the residue contains more than 90 per cent of $CaSO_4$. The aspect of the conversion changes quite remarkably and completely if the reaction is carried out i nthe absence of oxygen. It is, however, essential that the nitrogen used for the reaction be freed of every trace of oxygen by being passed over hot copper.

Effect of CaS on $CaSO_4$ in a Current of Nitrogen

Temp. °C.	Sample Grams	Sulfur Expelled Grams	Sulfur Expelled %	Composition of Residue % CaS	% $CaSO_4$	% CaO
800	0.250	0.0014	2.1	15.3	81.0	3.7
900	0.250	0.0112	17.0	14.2	75.4	10.3
1000	0.250	0.0660	100.0	2.2	....	97.8

The reaction starts somewhat below 800 degrees C. but is complete at 1000 degrees C., the total calcium sulfate is consumed, the excess of calcium sulfide remaining unchanged. Consideration of these various researches shows us positively that recovery of the sulfur of calcium sulfide by air oxidation is very incomplete as the largest part (two thirds) of the calcium sulfide is converted to calcium sulfate. Furthermore the interaction of calcium sulfide with calcium sulfate, which is complete at 1000 degrees C. in the absence of air is hindered very distinctly by blowing in air so that in this case only a small fraction of the sulfur dioxide can be recovered.

Oxidation of Slag Sulfur by Air

An experiment was also conducted to convert the sulfur of blast furnace slag to sulfur dioxide by oxidation with air. 5 grams of finely powdered Upper Silesian blast furnace slag were heated for one-half hour in the furnace at 1000 degrees C. The sulfur dioxide absorbed in the train showed a yield of 24.6 per cent. The rest of the sulfide sulfur was converted to calcium sulfate.

Decomposition of Slag Sulfur by Calcium Sulfate in a Current of Air

20 grams of slag were mixed with 2.05 grams of anhydrous calcium sulfate. The mixture contained 0.86 per cent sulfide sulfur and 2.30 per cent sulfate sulfur. The time of reaction was one-half hour.

Temp.	Sample	Sulfur Expelled	Composition of the Residue	
°C.	Grams	as SO_2 (%)	% Sulfide S	% Sulfide S
800	2.127	2.3	0.14	2.77
900	2.331	10.8	0.125	2.68
1000	3.082	16.4	.....	2.63

In a current of air even at 1000 degrees C. only 16.4 per cent of the total sulfur was converted to sulfurous acid. The amount of sulfate sulfur is larger after heating than before.

Decomposition of Slag Sulfur by Calcium Sulfate in a Current of Nitrogen

Temp. °C.	Sample Grams	Sulfur Expelled as SO_2 (%)	Composition of the Residue % Sulfide S	% Sulfide S
800	2.041	12.4	0.78	2.04
900	2.210	66.0	0.38	0.85
1000	2.329	100.0	0.178	...

In a current of nitrogen the reaction between calcium sulfide and calcium sulfate even in the slag is quantitative. At 1000 degrees C. the conversion is complete and only the slight excess of sulfide sulfur in the slag remains unaffected. The reaction conditions existing between calcium sulfide and air, and calcium sulfide and calcium sulfate in a current of air or nitrogen, either for the pure substances alone or in blast furnace slag are all similar in that the conversion to sulfurous acid in the presence of air is very incomplete. The action of blast furnace slag is striking if we compare the results in a current of air or in a current of nitrogen for the same temperatures. The reaction velocity is greater in the slag; it must, therefore, be assumed that the silicates or aluminates act catalytically in the slag in a manner similar to the conditions shown by the various patent claims. The influence of the manganese sulfide present in the slag is, as we have determined, unimportant.

The above experiments show very clearly that the oxidation of slag sulfur by air alone according to Diehl's German patent 299151 at temperatures below 1200 degrees C. where dissociation of the calcium sulfate does not occur is very limited. Also the decomposition of calcium sulfide by calcium sulfate in the slag by an air current according to Diehl's German patent 301613 is very limited. The "oxidation" by air in Diehl's patent for the utilization of slag is no advantage but a disadvantage. If Diehl in his large scale tests on adding gypsum to slag and blowing air through the charge obtained a conversion of 40 per cent this may be explained only by assuming a dissociation of some of the calcium sulfate at temperatures above 1200 degrees C. as is confirmed by the analysis of the residue. But Diehl's process prevents the utilization of these higher temperatures necessary for dissociation by blowing in cold air.

Summary

The proposals in the patent literature tor recovering sulfurous acid from gypsum are reviewed and it is shown that the decomposition of gypsum by dissociation is seldom attempted, but it is quite usual to attempt to facilitate the decomposition by additions of quartz, clay, coal, iron oxide, etc. Then the temperature relations for the decomposition of gypsum by dissociation and by the various additions are investigated.

The proposal is made to utilize the heat content of blast furnace slag in order, in a way, to accomplish the dissociation of gypsum without the use of fuel. Experiments show that sulfur recoveries of 95 per cent can be attained. Any slag is suited for this purpose and not only those rich in sulfur. But also from the latter the sulfide sulfur may be obtained in yields of 90 per cent by adding gypsum.

Proper Manner of Capping Fuse

The Bureau of Mines and the manufacturers of detonators, of explosives and fuse have published much information on the proper manner of capping fuse. This work should be done by a well qualified man, and most large mining companies employ a special man for the purpose. Generally, the fuse house is on the surface, and capped fuse is sent down to underground lockers as needed. The work should be done in a dry place and care taken that all fuse for specific purposes be cut accurately to length. The fuse should be cut squarely across with a sharp instrument. The caping of the fuse with the detonator should be done in such a manner that the explosive composition of the detonator fits snugly against the end of the fuse. Also the detonator should be securely crimped on the fuse, in order that the fuse will not be pulled away from the detonator during loading, or by the concussion of preceding shots. The detonator should be crimped in such a manner that the powder core of the fuse will not be pinched.

Capped fuse should be sent underground in closed rigid containers and taken to detonator lockers which should be at least 50 feet from powder magazines.

Limestone For Sewage Filter Beds

Limestone quarrymen and sanitary engineers will welcome a forthcoming publication on the subject of qualities desirable in stone to be used for filter beds in sewage treatment plants. In view of the great quantities of stone required for this purpose, 650 carloads in one plant for a town of 25,000 people, for example, it becomes very desirable to establish standard tests to indicate how a given stone will resist disintegration when used in filters.

The Illinois State Geological Survey has prepared a suggestive list of qualities desirable in filter stone and has devised laboratory methods of testing for these qualities, as described in its Report of Investigations Number 12, which is to be issued presently for distribution to all who may be interested. This report was written by J. E. Lamar, Geologist of the Division of Non-Fuel Products of the Survey.

The desirable properties of a good filter stone are specified as follows:

(1) The stone should be of minimum apparent porosity.

(2) The pores of the stone should be small and evenly distributed.

(3) The stone should consist of well-interlocked crystals or, if it is granular, the grains should be firmly bonded by a strong cement.

(4) The stone should be of approximately uniform solubility.

(5) The stone should be free from minerals which oxidize or hydrate. Pyrite and marcasite especially are to be avoided.

(6) The stone should have a sufficiently rough surface to furnish anchorage for the bacteria which are to grow upon it.

(7) The stone should be comparatively pure chemically. Stones with high clay contents are generally to be avoided. A high siliceous content is probably not harmful if the silica occurs in fine crystals evenly disseminated.

(8) The stone as delivered to the filtering plant should be free from dirt or fine rock particles which might collect in and clog the basal portion of the filter bed.

The laboratory tests designed to furnish a basis for judging the comparative merits of different limestone and dolomite filter stones, both mechanically and chemically, are grouped as follows: (1) Accelerated soundness test; (2) freezing test; (3) absorption test; (4) microscopic examination; and (5) solution tests, including etching by hydrochloric acid. Tests for hardness, toughness, and wear are also evaluated.

THE "GETTING BY" HABIT

By Harry Eldredge
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AN EXPRESSIVE and seemingly popular American phrase, heard on all sides today is that of "getting by," "Well, I got by, all right," "Do you think you can get by?" etc. This phrase, curiously enough, often is used rather proudly, in some cases boastfully, when, as a matter of fact, it is frequently a significant reflection on the user. The expression "getting by" is being used in countless ways by men and women in all walks of life. At times it creates a frame of mind which might well warn certain younger members of the present generation, both in school and in business to pause and take stock.

It has well been said that "to be of service to others is one of life's greatest privileges"; also that rendering service, is to do something worth while for someone else; to do something we don't have to do or "more than we are expected to do." The farsighted business man of today—the man with vision—is in complete accord with the spirit of that famous Rotary slogan: "He profits most who serves best." Not only is he in accord with it but, as a good business man, he does business on that basis daily; likewise he pursues the same policy when "off the job."

This "getting by" attitude, is contrary to that spirit of true service; in fact it is a short-sighted frame of mind with a boomerang attached. Whether used between business men, between customer and firm, or between customer and firm, or between employer and employe, when you get right down to cases, might not "getting by" be associated with the idea of "putting something over" or "How little can I do (or give) and get away with it?"

An old and overworked platitude tells us that "We get out of life what we put into it." Experience usually demonstrates that to be the case, both in social and business life. As a rule, we get back what we send out and not infrequently with liberal interest. A blossom may come back a grown flower; an uncharitable act or word in the form of a brickbat, or other "unprofitable return." The attitude of "Can I get by?" must be changed to "How much can I do?" or "How far can we go?" if the man or firm who expects to progress is actually to do so. Would it be too much to say that almost anybody with average intelligence can "get by" (and stay where he is)? But is it enough merely to "get by?" Is any ambitious man or woman content with just that?

With competition for new business as keen as it is—also competition for better jobs—it must be recognized as the responsibility of the man who expects to get that new business or who expects to land that better job, to display real initiative, energy and unquestionable evidence of 100 per cent reliability. Otherwise, he has little hope of selling the boss or prospective customer the idea that it will be to their mutual advantage to get together, and that failure to do so will operate toward a certain loss for both of them.

The man who works on the basis of "getting by"—of trying to get as much and give as little as he can—is pretty likely to get, not what he hopes for, but rather what he has coming to him, and justly so. And if the thought and energy so frequently applied to "getting by" were devoted to doing the thing at hand in the best possible manner, the net results undoubtedly would be startling. In the interest of cordial relations and success generally, let us try to change this "getting by" attitude. Rather, let us ask ourselves "how far can I go?" "How much can I consistently do for the other fellow, be he firm or patron, employer or employe?"

Railroads Will Be Good Customers

Throughout 1926 there was much talk and not a little astonishment at the long sustained high level of car loadings. In several individual weeks of last year total car loadings exceeded all previous records, while throughout the 12-month period the sustained high volume of shipments was most unusual. In addition to being a barometric indicator of healthy general business conditions, exceptionally heavy car loadings and more especially long sustained high levels, mean that railway equipment is being worn out. Indeed, it is a generally acknowledged fact that railroad equipment did endure excessive wear last year and that the placement of large orders for locomotives, rolling stock, and auxiliary equipment is now necessary.

Both large and small railroads are good buyers right now, and many of the larger systems have indicated their intention to remain so far into the year. This should not only mean much to the producer of freight cars (whose business during 1926 was over 25,000 cars less than 1925 and one of the lean years of recent history) but to manufacturers of all manner of auxiliary equipment from couplers, signal devices, rail equipment, machine tools, cranes, coal storage equipment, building material, etc., to electric light bulbs. Anyone who numbers railroads among their customers might well direct an increased amount of advertising and sales effort to that field.

CRUSHED STONE FOR SEWAGE FILTERS

By George B. Gascoigne
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CRUSHED stone has for years occupied a conspicuous space in our economic life, being used extensively in highway, railroad and building construction. Only within recent years, however, has crushed stone become a factor in public health engineering, yet today it constitutes one of the principal agencies in the treatment of sewage, which has become a recognized necessity in the preservation of our health and comfort. For the purpose of convenience in this discussion, the term "crushed stone" includes limestone, granite, trap rock, slag, gravel and other similar materials when used only as filtering material in sewage filters, and particularly trickling filters.

Trickling Filters

Before describing the manner in which crushed stone is used as a filtering media, it is well to outline briefly the steps leading to present practice. With increase in population the matter of sewage disposal naturally becomes more and more urgent, and is of particular concern in the more thickly populated sections. The scientific treatment of sewage by artificial means in this country, however, may be said to date from experimental work of the Massachusetts State Board of Health at Lawrence, Massachusetts, which began in 1886. Theretofore and for many years afterwards, the treatment of sewage was, and even in many places at the present time is by dilution, this is, discharging it without artificial treatment into the nearest body of water. The experiments at Lawrence developed the intermittent sand filter and the first municipal installation of this type was at Framingham, Massachusetts, in 1889. This was soon followed by others of similar type, many of which are still in service. While intermittent sand filters produced most excellent results, large areas were required and other experimenters began to try the use of coarser grained materials and from these investigations there was developed, first in England, the so-called contact filter. This filter permitted much higher rates than the sand filter. The first installation of contact filters was at Manchester, England, in 1890. Early installations of this type in America were at Plainfield, New Jersey, Canton, Mansfield and Marion, Ohio. While still used, the contact filter is rapidly giving way to another phase of its development, the trickling filter. Today the trickling filter is a recognized standard device for the artificial oxidation of sewage. Crushed stone constitutes the vehicle by means of which the treatment of the sewage is accomplished. It is called the filtering media and unless this media functions in a proper manner the filter becomes useless and valueless. It can be readily seen, therefore, that crushed stone in a sewage filter is of vital importance.

Briefly stated, therefore, a trickling filter is essentially an enclosure with earth, stone or concrete walls and a floor having a complete drainage system. The enclosure is filled with pieces of crushed material called, as stated above, the filtering media. The sewage is applied evenly over the surface either by fixed sprays or traveling distributors, trickles down through the crushed stone or media where the treatment is effected by bacterial agencies living and working in jelly-like films which form on and adhere to the individual particles of the stone. After the sewage has filtered or trickled through the entire bed, it is carried away by the underdrainage system to be discharged into the receiving body of water.

Operating Requirements

In order to emphasize the conditions which a material or media must meet in the normal operation of a trickling filter, some of the operating requirements will be described briefly, particularly in respect to the demands affecting the suitability of the media.

Effect of Sewage: Variations in the character of the sewage effect the filtering media in two ways. First, the suspended matter remaining in the sewage applied may cause surface matting and pooling and internal clogging; and secondly, the presence of certain chemicals in the applied sewage may accellerate or exert disintegrating or dissolving action.

Effect of Temperature: A trickling filter operating throughout the year in a climate such as is found in Ohio and vicinity is subject to wide extremes in temperature which may be as high as 90 degrees Fahrenheit in summer and as low as —10 degrees Fahrenheit in winter, a difference of 100 degrees. While temperature plays an important part in the treatment accomplished by trickling filters the matter of deepest concern to the producer of crushed stone is its effect upon the disintegration of the individual particles of the filtering media.

The weathering action of frost on stone is familiar to almost everyone. In the crevices of large boulders exposed to the elements there can usually be found pieces split off by the action of alternate freezing and thawing. On a trickling filter there is an intensive freezing and thawing effect during

*Paper read before the Ohio Crushed Stone Association, February 9th, 1927.

the cold weather, but instead of such action being occasional it is almost continuous. The usual method of applying sewage to a filter by means of a spraying nozzle is such that spraying occurs for about 5 minutes and then ceases for some 10 to perhaps 30 minutes or even an hour when the flow is lowest. Moreover, the lowest rate of flow occurs during the night when the cold or the freezing action is usually most severe. Sewage as compared to the surrounding atmosphere on a cold day is relatively "hot." With a temperature of 0 degrees Fahrenheit or even lower, the applied sewage may have a temperature of say 35 to 40 degrees Fahrenheit. This relatively warm sewage striking the individual pieces of frozen filtering material thoroughly wets them and exerts a "thawing" effect. During the interval between sprayings the surface may freeze again. Consequently, in a period of 24 hours during freezing weather the surface of the filter may be partially thawed and frozen as many as 50 times. It should be mentioned also that while portions of the bed may be covered with ice constantly during cold weather, short periods of thawing temperature will almost completely remove the accumulated ice. It will be seen therefore, that the filtering material is almost always wet or frozen. In view of these facts it is obvious that the surface of a trickling filter affords ideal conditions for weathering action effected by alternate freezing and thawing.

Effect of Suspended Matter in Sewage: The function of a trickling filter may be stated as being two-fold. First, to remove and hold the finer suspended solids and colloidal matters which do not settle out by gravitation until they are transformed into material resembling humus when they will slough off; and second, to change the organic matters in solution into non-putrefactive, stable, mineral forms. All of these changes are brought about through the biological action of worms and microscopic organisms known as bacteria. These organisms live and perform their work in a jelly-like coating or slimy film on the individual pieces of the media. In a healthy bed this jelly-like coating teems with bacterial life and with worms of various sizes visible to the naked eye in numerous quantities. In order, however, for this biological life to effect the desired changes in the sewage, which may be termed the "degree of purification," it is essential that there be an abundance of air in the filter. For this reason there must be adequate rest periods between sprayings, otherwise the filter would be what is termed "drowned out." Also, there should be at least 40 per cent or more of voids or interstices in the media so that the passage of the sewage will not be unduly hindered. If the voids become filled with suspended matter removed from the sewage it is obvious that the filter will become clogged, an ample supply of air will not be available, consequently its effectiveness will be greatly lowered if not destroyed. Nature, however, has provided that in a filter with the proper media the solids which are usually stored during the winter, are sloughed off and washed out during the early spring. This is called unloading of the filter and is undoubtedly brought about in large measure by increased biological actvity which is always greatest during the warm weather. However, with materials lacking in smoothness, it has been found that the "sloughing off" action does not always occur to the required degree.

Effect and Size of Surface Area: It is an accepted fact that in two trickling filters of the same depth dosed with the same sewage the quality of the effluent will be affected by the size of the filtering material. The smaller the particles the better the purification. The reason for this lies in the fact that with the smaller particles there is a larger surface or bacterial area per unit volume than with larger particles. Since the bacteria which effect purification operate in films on the surface of the stones, it follows that the larger the surface area the more bacteria there are that function. Furthermore, it is obvious that the rougher the surface of any material the greater will be the bacterial surface. Consequently, experience and tests have demonstrated that a rough material, such as slag, will effect greater purification, for a time, than will smooth material, such as limestone or pebbles. Unfortunately, however, both size and roughness are limited by other physical requirements. If the particles of filtering material are too small, surface and internal clogging will occur, when too high rates of application are used, and the performance of the filter fails. Also, if the material is too rough the stored solids will refuse to slough off, thereby causing clogging. It is therefore necessary that a proper balance be observed so that filters can be dosed at high rates and still operate effectively. In early installations the size of the filter material was relatively small, say around ½-inch. This has graduálly increased until the specifications of 1 to 2 inches, common several years ago, are being replaced more recently by a tendency to larger sizes, say 1½ to 3 inches. The proper sizing of filtering material is of paramount importance.

Summarizing, a suitable filtering material must not disintegrate nor should it have cementing or amalgamating qualities under certain physical or chemical conditions existing in filters which cause it to clog. Also, the material must not clog either because of the fineness of the material or because the surfaces are too rough to permit proper unloading or sloughing off.

Past and Future Demand

The modern trend of scientific opinion is toward the conclusion that, in general, where filtration is

to be used for the oxidation of sewage the trickling filter provides one of the best devices. This is true apparently even for relatively small communities, since this type of filter is usually adaptable, requires less area, affords higher rates per unit of filtering material and effects satisfactory results economically. This is evidenced by the fact that within the past five years large trickling filters were placed in operation at Decatur, Illinois, Lincoln, Nebraska, Madison, Wisconsin, Worcester, Massachusetts, Canton and Marion, Ohio, and other places.

At the present time there are in the United States over 400 trickling filters varying in size from less than one-tenth of an acre to the largest installation of 30 acres at Baltimore, Maryland. Of this number there are perhaps 30 installations with an area larger than one acre. Probably the low number of relatively large installations is surprising. The future appears promising to the producer because from present indications many installations of the larger size will occur during the next ten or fifteen years.

The 400 sewage plants have required the use of more than one and a half million tons of filtering material, fully one-half of which has been required since 1916, notwithstanding the fact that during the war and for the next few years following high prices curtailed much municipal work. Present indications point to more activities on the part of both municipalities and industries in the way of treatment for domestic sewage and industrial wastes. In fact, judging from the work now in progress or contemplated, it seems safe to conclude that within the next five years fully 600,000 tons of filtering material will be required in and close by Ohio.

Suitability of Materials

Various kinds of crushed stone when used as filtering material have been found to disintegrate, have cemented or amalgamated under certain physical or chemical conditions existing in the filters, and have become clogged either because of the fineness of the material or because the surfaces have been too rough to permit proper unloading. Having in mind these conditions which have been observed in existing installations, it is interesting to note what requirements have been used for the materials in the past.

In practically all former specifications it has been stipulated that the filtering material shall not contain any appreciable amount of dust, dirt, clay or sand, shall be hard and sound, free from seams and porous spots and when shaken in clean water shall leave the water substantially clean and clear. Cleanliness has therefore been considered an important requisite and to the extent that in a number of cases washing of the materials was required just prior to their placing in the filters. Also, careful sizing of the materials, within specific limits, has always been emphasized in specifications for filtering media. On the other hand, no uniform or practical methods for measuring the suitability of a particular material have actually been in use. In practically all cases the quality of the material was to be subject simply to the approval of the engineer.

It is now recognized, particularly in view of the relatively unsatisfactory performances of some materials, that more definite specifications regarding the suitability of filter media should be established. With this in mind, the American Society of Civil Engineers in 1925 appointed a special committee on filtering material. This committee, centering its efforts on sewage filters, has now been at work for two years collecting data from existing installations. The purpose of this is to correlate these data with the kind of material suitable for trickling filter media and just how that suitability shall be determined. From the foregoing it may be deduced that a trickling filter is more than just a "heap of stones."

Sampling and Testing: It is appreciated that definite procedures have been established to determine the suitability of crushed stone for use in highway construction or in concrete. It is obviously natural to conclude that the same might be done to establish the suitability of crushed stone for trickling filter media. It does not follow, however, that a stone which will be satisfactory for highway construction, railroad ballast, or concrete, will be satisfactory for a trickling filter. There are certain materials such as trap rock which we know will withstand the action of the elements and meet requirements for many years. There are others which we know are entirely unsuitable for concrete or road building.

As suggested in the forepart of this discussion, crushed stone for trickling filter media to be suitable should conform to three basic requirements after continuous service over a period of years.

It must be durable—that is, it must not disintegrate.
It must not pack or cement together.
It must be such that the accumulated suspended solids will slough off periodically.

It has been suggested that certain chemical constituents in a crushed stone make it unsuitable for trickling filter media. This point has not been fully established. However, research is now being conducted along this line. In general, it may be stated that although it may be shown by tests that a stone conforms to certain requirements as to hardness, porosity and specific gravity, it does not necessarily follow that a particularly hard stone is more desirable for a trickling filter media than a soft stone. Furthermore, the porosity of a mate-

rial does not necessarily bar its use. These are some of the matters which are now under investigation and it is confidently hoped that within the next two years we shall be able to definitely recommend certain physical and chemical tests which may be applied to a material which will definitely determine its suitability or non-suitability for trickling filters. The more nearly these tests can conform to standard tests now in practice for other uses the better will both the producer and prospective purchaser be enabled to compare these standards with those used in the past for other purposes.

In all testing work the sampling is the important feature, and for this reason, irrespective of the tests applied, the utmost care should be taken to secure a sample which will be representative of the source and the material furnished upon the work.

Conclusions

At the present time there appears to be sufficient demand, actual or prospective, for crushed stone in sewage filters as to make its preparation an essential part of the program of the crushed stone producer. Without doubt within the next few years many places will install sewage treatment works and a goodly percentage of these will include trickling filters. It can readily be seen that the nearer the source of the material is to the market the lower will be the cost, and the cost is a very important factor in the use of crushed stone for sewage treatment.

Not every quarry can be considered a source of supply for trickling filters. It may be that some parts of a quarry will contain material entirely satisfactory while other parts may contain a material equally as unsatisfactory. It can be seen therefore, that where several sources contain materials which are satisfactory the source to be preferred is the one in which the material is the most uniform. In fact, it is conceivable that a slightly inferior stone of uniform quality may be preferable to a source of supply which contains large percentages of both good and poor material. This brings up the question which producers may have to face in the relatively near future, of whether or not it is possible to segregate various kinds of material for specific uses. Oftentimes a material when first taken from the quarry appears unsuitable. Yet, after curing for a considerable length of time this material may be entirely satisfactory. Where material is to be supplied for trickling filters it may be advisable to have a sufficient output capacity so that the material may be stored and cured before shipment.

The effect of a small amount of poor material in an otherwise good stone is illustrated in one of the large filter plants built recently, in which material from a very thin ledge of poor quality was mixed with a satisfactory material. The poor stone disintegrated considerably soon after placing, giving the impression that the whole mass was unsatisfactory, which, however, upon close examination, proved to be unfounded. This merely demonstrates the importance of having all material of the requisite quality.

Sewage filters can be considered a live market for crushed stone. Those who sell the product will be faced with the necessity of supplying a material, the requirements of which for proper performance are different in some respects than the requirements usually found in the ordinary uses of crushed stone. These newer requirements will involve synchronizing the viewpoints of the salesman and quarryman, the former when selling the product having to meet a terse quality argument while the latter is faced with the problem of quantity production. Both are confronted in the future with furnishing a material that will slough off properly, yet it will neither disintegrate nor consolidate. Also, as time goes by there will be developed yardsticks for establishing the limitations of these quantities.

Proposed Changes in Trademark Laws

Business men in general should be interested in the proposed new Federal trademark law if for no other reasons that it will triple registration fees, fix time limitation in establishing abandonment, and provide territorial divisions for trademark usage. The new law embodies a clause that adjudges any mark abandoned that has not been used for a period of two years. This clause may militate against some present holders, although it should greatly simplify the present difficulty of procuring evidence of abandonment. One of the most radical changes to the old law is that of permitting the registration of the same mark for goods of the same kind by two or more claimants, providing there is an agreement among the applicants allowing the Commissioner to grant certificates for limited geographical sections in accordance with such agreements.

Instead of permitting the registration of only those marks used on merchandise, the proposed law would embrace marks of services, corporation names, organizations, societies, unions, and other bodies. This provision would make protection possible for not only trade marks that are used to identify goods or merchandise, but trade names and other insignia that might identify only services. The new law further provides that application for registration must be made within one year after the adoption of a given mark, name or symbol. Failure to make application within this time would impose upon the applicant a registration fee equal to three times the usual fee.

GOOD MANAGEMENT REFLECTED IN DETAILS OF PLANT OPERATION AND ROUTINE

By F. A. Westbrook

"CLEANLINESS is next to Godliness," says the old proverb which might be paraphrased from the industrial management viewpoint by stating that "Cleanliness is the essense of good management." In any event, almost all well managed plants are kept clean and tidy and, conversely, practically all orderly plants are well run. Certainly nothing creates a better first impression than the absence of rubbish about the grounds and tidiness in the buildings of a plant.

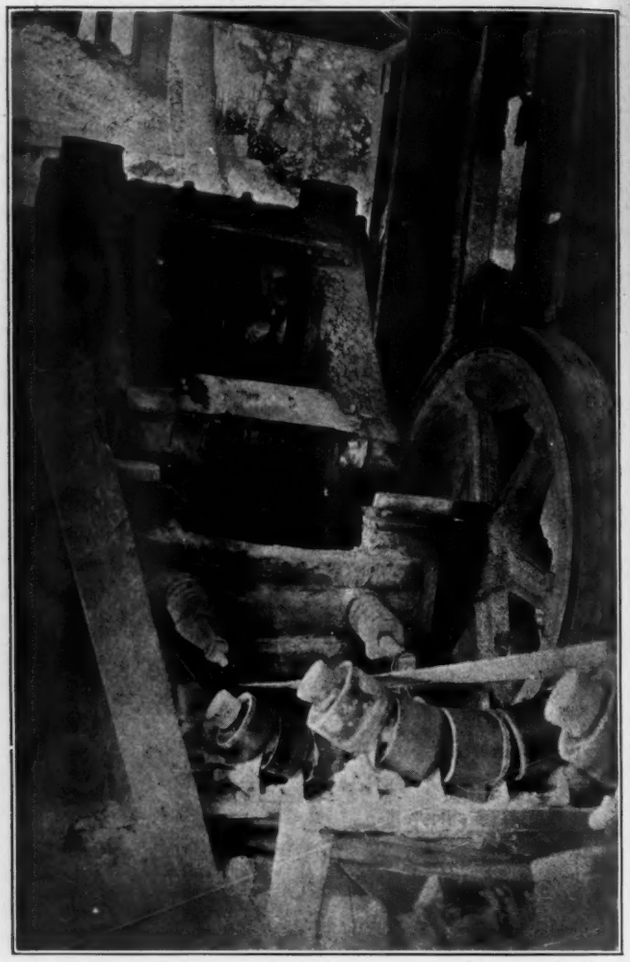
The Brandon Rock Products Company practices this virtue. At the Forestdale, Vermont, plant, near Brandon, where cream and pink stucco marble chips are produced, the entire place is so well kept that one instinctively does not throw away an empty tobacco can. There is a handy receptacle for just such things. Furthermore, the mill is swept out thoroughly every Saturday and dust in the motors is blown out at frequent intervals. Mr. M. H. Steele, the superintendent, takes great pride in this feature of the plant. This cleanliness is necessary because it is essential that the marble chips, used for decorative purposes, be kept free from foreign matter and the only way to do this consistently is to organize the whole operation on a basis of the most scrupulous cleanliness.

The cream and pink marble found at this quarry supplements the white chips obtained at this com-

View of Pit Showing Incline to Plant

General View of Plant

Tracks to Platform (in background) Where Stone is Dumped into Primary Crusher



Primary Crusher Showing Beginning of Belt Conveyor to Secondary Crusher

Conveyor from Primary Crusher to Secondary Crusher

Turn Table in Quarry for Switching Cars in Various Directions

pany's works in Middlebury, Vermont, described in September 1st, 1926 issue of Pit and Quarry, and completes the line. These colored chips take a good polish and are used for high class work, for instance, 4,000 bags were used for flooring, etc., in the New York Public library. The pink and cream colored stone occurs in two distinct veins separated by a vein of light pink which is frequently mixed with white. One of the illustrations shows how the two veins are being quarried and how the light pink has been taken out to a lesser extent.

To obtain the stone, holes are drilled vertically by Ingersoll-Rand jack hammers, fitted with hollow octagonal drills. The holes are made 10 feet deep, 3 feet apart and 4 feet back from the breast. From three to thirty-five holes are drilled at a time and with the present large demand for this material, it is necessary to drill and shoot at least thirty-five holes a week. Trojan 40 per cent and 60 per cent dynamite is used for blasting and Hercules electric blasting caps for setting off the charges. A 9x18 inch Chicago-Pneumatic com-

View of Quarry Showing Tracks and Veins of Pink and Cream Colored Stone

Lower End of Incline in Quarry and Men Working at Loading Dump Cars

View of Shaking Screen

pressor is used to supply air for the drills. This compressor also furnishes the air for blowing dust out of the motors.

A rather ingenious and very practical arrangement has been made to insure safety and also save time when firing the shots. This consists of a timbered shed, located near the crushing plant,

End Dump Car on Incline from Quarry

from which a 110 volt electric lighting circuit is extended into the quarry. First a lamp is used to test the circuit to make sure that it is alive. The shot is then fired by closing a switch inside the shed. This arrangement is a permanent installation and being always ready for service no time is lost in getting ready to shoot a blast.

The means for transporting the stone has also been very efficiently developed. Movable tracks, over which are operated two 1 ton Koppel end dump cars are used in the quarry to move the stone. Of course, these tracks must be moved from place to place where the quarrying is being done. To facilitate this, they are arranged in sections 15 feet long, the rails being bolted to steel ties. Two men can easily carry one of these sections. A turn table has also been provided by means of which the cars may be switched to different parts of the quarry, to the dump or to the crushing plant. The waste stone from the quarry is used for filling in and leveling the working space. The quarried stone is sorted by hand in sizes not larger than 150 pounds and placed in dump cars.

Two Men Carrying a Section of Track in the Quarry. Note the Turn Table in Foreground.

Bag Storage Shed. Note Concrete Foundation and Neatness of Premises

Vibrating Screen with the Cover raised

The larger pieces are broken by sledges or the very large blocks drilled with a jack hammer. The broken material is then dumped on a platform and drops to a Champion jaw crusher.

A Robins conveyor with a 12 inch United States Rubber Company belt carries the crushed stone to the secondary crusher. A man is stationed at this conveyor to pick out dark or otherwise unsuitable pieces of stone which might tend to spoil the color of the finished product. The secondary crusher is a number 25 Kennedy gyratory. A bucket elevator, made at the plant with a United States Rubber Company belt, carries the stone from the secondary crusher to a Kennedy heavy duty shaking screen. This takes out the large sizes and actually functions as a sort of scalping screen.

The throughs from this screen pass to a Sturtevant Moto-Vibro screen which takes out the dust. Everything which passes through a number 70 mesh screen is wasted. Four commercial sizes are obtained from this screen. The tailings, or oversizes, from the Kennedy screen drop to a Sturtevant roll crusher, again picked up by the elevator and returned to the Kennedy screen.

The chips are deposited in bins from which they are drawn off by the bagging machines. On these machines, the Bates Valve Bag tier is used but the rest of the bagger was designed by the Brandon Rock Products Company and made by the Fair Haven Foundry and Machine Company. Bags are obtained from three different manufacturers, the Atlantic Bag Company, the Jacob Larsen Bag Company, and the Fleischer Brothers Bag Company. Shipments are made by truck to the railroad station at Brandon, a distance of about three miles. The material is weighed before shipping on Fairbanks scales.

The motors used to drive the various machines are as follows: 25 h. p. Fairbanks-Morse for the Champion crusher; 25 h. p. General Electric for the Kennedy gyratory crusher; 20 h. p. General Electric for the Kennedy shaking screen; 5 h. p. Westinghouse for the Sturtevant Moto-Vibro screen and elevator; 25 h. p. Westinghouse for the Sturtevant roll crusher; 20 h. p. General Electric for the Chicago Pneumatic compressor.

The electrical work has been carefully installed with a control for the motors grouped at a central point. This arrangement seems to be the modern tendency in new plants and undoubtedly makes for efficient operation and safety. The power transmission belts used with the motors are chiefly United States Rubber Company Rainbow manufacture. Alligator belt hooks are used for both transmission and conveyor belts.

Ballast Committee of A. R. E. A. Makes Report

At the twenty-eighth annual convention of The American Railway Engineering Association held March 8, 9 and 10th, the Committee on Ballast, referring to Test number 4, Proportion of Aggregates in Washed, Crushed and Screened Gravel, said:

A sample of the prepared ballast weighing not less than 150 lb. shall be thoroughly dried, weighed and placed on a screen having holes 1½ inches in diameter; all material which can be passed through this screen shall be placed upon a screen having holes 1 inch in diameter; all material which can be passed through this screen shall be placed upon a screen having holes ½ inch in diameter; all material which can be passed through this screen shall be placed upon a screen having meshes of ¼ inch, and all material which can be passed through this screen shall be placed upon a number 10 screen, and all material which can be, shall be passed through it.

If the ratio of the amount of material retained on the 1½ inch screen to the amount of the sample as a whole exceeds two per cent, the product shall be rejected until the fault has been corrected. If the ratio of the amount of material passed a number 10 screen to the amount of the sample as a whole exceeds three per cent, the product shall be rejected until the fault has been corrected.

If the ratio of the amount of material retained on each of the screens to the amount of the sample as a whole does not come within the tolerances given above, the material shall be rejected until the fault has been corrected. In conclusion the committee recommended that the foregoing test be added to the "Specifications for Washed Gravel Ballast," as adopted at the 1926 convention.

On the relative value of stone as ballast from various quarries and method of determining the Committee felt that at present there is not enough data, on ballast of proven merit, to establish any equating coefficients or other arbitrary values whereby one ballast may be given a higher numerical index than another. To establish a standard as to absorption, hardness, toughness and wear would require a large number of tests of ballast of proven merit. Such a standard would seldom be of service, as the choice between usable materials is usually limited by length of haul, and totally unfit sources have been eliminated by experience. The committee was of the opinion that the benefits to be derived will not justify the expenditure necessary to make sufficient tests to obtain data upon which to base conclusions on the topic assigned.

However, on the shrinkage of ballast, with a view of determining to what extent, if any, this information as outlined above was being used by members of the Association, a questionnaire was prepared and sent to members of the Association. The questions and answers are as follows:

1. Is ballast purchased by the cubic yard or by weight?

(A) Forty reply by weight; 14 by cubic yard; 11 by both weight and cubic yard.

2. If purchased by weight, is it computed as placed in track by weight or by cubic yard?

(A) Fifteen reply by weight; 44 by cubic yard.

3. How is the total yardage of ballast used determined on completed work?

(A) Forty-six reply by using amount purchased; 4 by measurement.

4. What percentage of shrinkage is allowed for each kind of ballast used as between ballast in place and ballast at place of origin?

(A) Sixty-four replies received to this question: 13 report a percentage of shrinkage on certain ballast:

Stone ballast	9.3 per cent
Slag ballast	14 per cent
Washed gravel ballast	14½ per cent
Pit run gravel ballast	13¾ per cent
Cinder ballast	20 per cent
Burnt clay ballast	16¼ per cent
Chatts ballast	10 per cent
Oyster shell ballast	7½ per cent

The Committee concluded that in view of the fact that no information has been received which is in conflict with the matter now in the Manual at the present time, the Committee recommends that the subject be discontinued.

Is Steel Really Fire-Proof?

Within the past month two factories located in approximately the same district of Chicago burnt out completely. Both were assembling plants, of a similar size, single story, the only outstanding difference being the roof construction. Both buildings were of masonry walls and the roofs of truss construction—the one being wood, the other steel truss work. The building having the wood roof truss burnt to the ground, leaving only the walls standing. In the reconstruction, therefore, it was necessary to clear away the debris, reinstate new wood trusses on the side walls and replace the roof.

The building having the steel truss became so hot in the intense heat that when water was applied the steel buckled, thereby not only ruining the truss construction but pulling down the side walls as well. In the reconstruction it was necessary to cut the twisted steel in order that it could be removed, then start from the ground up and build a complete building, walls and all. In the former case (wood truss construction) production was resumed ten days after the fire. In the latter (steel) ten weeks were required in demolition and construction work and full production was not resumed for a period of three months after the date of the fire.

MARKET ANALYSIS

By Arthur Livingston
McKinney, Marsh and Cushing Company*

FIGURES play an important part in market analysis. Business, however, has passed up the use of figures rather shamelessly. There is a great deal of attention given to salesmanship, the training of salesmen, salesmen's conventions, advertising, advertising stunts, sales manuals and the like, which are all needed, but figures and their potency are lost sight of in the every day rush of selling goods. Even in their bookkeeping departments, where they watch profits and losses, firms have been reluctant about expanding their use of figures and adopting the up-to-date systems of accounting. Ten years ago the bookkeeping methods used by the majority of concerns in the country were very poor, reflecting what people naturally think of the value of figures. But two things happened to effect a change; first, the income tax law, when passed, demanded a careful accounting of all business transactions, and, second, the makers of mechanical bookkeeping machines and bookkeeping forms went out and taught people better methods and sold their machines and forms in the bargain. Today you find a high standard of accounting prevailing from the top all the way down to the small retailer.

Some years ago something happened which advanced the use of figures in the sales and advertising departments of business. It was not the passage of a law, nor the work of any force of salesmen. Business men gradually became conscious of a need for more information. Heretofore, they had been getting business but they did not know where they were getting it from, except in an abstract way. They were selling goods without caring how many different varieties they were selling, so long as they sold a fair volume of something. Sources of business became an interesting study. The names of buyers, the kinds of business buyers were in, where they were located, why they bought and the uses to which articles were put, became interesting material to chart, make diagrams of and to talk about. It rightfully took the name of sales analysis and most market analyses start with an analysis of sales.

The need for statistical information first became talked about in association meetings. At first they complained about the small amount of data which was available. Lots of these organizations arranged to have their members pool their sales figures so they could get a line on the whole market. You know that all the manufacturers of automobiles who are members of the National Automobile Chamber of Commerce, send in monthly reports giving the number of cars shipped from factory to dealer. The Association Secretary assembles this material with a composite report which is sent to all the members. This informs each member what the whole industry is shipping and accounts for your hearing automobile production figures quoted. Members of the Rubber Association of America, Inc., do the same thing. Each one sends in a report of his sales, by districts, and in this way the total market for all kinds of rubber goods is revealed and they have gone a long way in solving some of their sales and advertising problems. Perhaps some of their competitive wrangles are ironed out in this way.

The paper industry due to a pooling of its figures knows not only how much paper of all kinds is being sold all over the country, but knows how much is in production and how much is on hand in dealers warehouses. They even report on the amount of raw material on hand. This system protected them in 1920 and this industry was one and the only one that I know of, which was not caught with a high inventory. Let your thoughts roll back to that time and think of the predicament that so many firms were in. I have been told that the paper industry is the most statistically controlled industry in the country.

However, the automotive industry knows a thing or two. There is available to automobile manufacturers a service which makes known how many automobiles of all makes are sold in every county of the United States each month. This is not the outcome of pooling figures, but is a service given by an outside concern. It costs this concern possibly $50,000 a year to put people in the state departments of each state who analyze licenses and draw off this information. The automobile manufacturers pay a good sum for this service. You can see what it means to them. They know each month the number of automobiles sold in each county, of all makes. This of course is worthwhile sales analysis.

Many concerns have arrived at the place where they maintain their own statistical departments for the sake of market analysis. They attempt to find out chiefly

1. Where they ought to get business from.
2. How much they ought to get.
3. How much they are getting against their ideals.
4. Where their weak points are.
5. The sales man-power they ought to have.
6. Where that man-power should be placed.

*Presented before the Tenth Annual Convention of the National Crushed Stone Association, January 18th, 1927.

These things are possible in a well arranged statistical department. We have heard the need of statistics derided, yet, I am here to tell you that there is a lot of debating going on in sales departments that could be decided quickly and decisively by a few figures bearing on the proposition. There may be a great many human opinions about the advisability of doing a certain thing but figures on the subject will tell only one story, and that one is the right one. You never hear anyone argue with a column of figures; the figures have spoken, all conversation ceases. Did you ever try to out argue the figures showing your bank balance? You may think you ought to have more money in the bank, you may feel yourself justified in having more, but when the accurately balanced bank statement says so much, you stop right there.

Several years ago a large company threw out its statistical department of some sixty people because they wanted to save money. Maybe they should have thrown it out for all the value it was, but in doing so they threw away the opportunity to improve it and to keep statistical track of their affairs. Today they would welcome any figures that would help them solve their many problems. They seem to be losing ground and they have very little of their own to guide them. In the absence of figures they have to rely on their own personal opinions and you know how far wrong a personal opinion can sometimes be.

Most sales work is simple. It is quite the same wherever you go. There is the sales manager, his salesmen, the selling talk, the demonstration of the product, the prospects and the calling on the prospects. There is really nothing complicated about a sales organization. The prescription as to what makes up a sales department is not a secret; everybody knows it. The factor which makes one department successful above another is sales arrangement. Sales management is greater than salesmanship. Sales managing is more than talking with dealers, satisfying customers, making loud speeches to salesmen, it includes a thorough knowledge of markets. It includes a thorough knowledge of where business can be secured, how much can be secured in each place, and from whom you are going to get the business. This kind of knowledge is born of good statistics.

A concern that I used to be with, the Burroughs Adding Machine Company, learned that their New York City manager was not trying to get any business from the so-called East Side. He said there wasn't any business in that district. Statistically this district was figured to be worth $90,000 in sales a year. So several of us went down into this district to look it over personally and we took the New York City manager along. We asked him to pick out the worst street, and I think it was Delaney Street he chose. In the middle of the block he stopped us and pointed his finger across the way and in no unmistakable terms told us that those stores were typical of the East Side district and that they were too poor to buy our product and had no use for it. Now where a company has a big volume of business you can't keep track of every order, but before going along this day, I examined the records and took down a few notes. As this New York manager was talking I looked down at my notes and what was my surprise but to learn that the very store he was pointing at had purchased our machine but a short time before. When I told him this he wouldn't believe it, but went across the street, into the store and insisted on seeing the machine, a device that cost about $450. He saw it and the proprietor told him why he bought it and that there were many others on the same street who should have one.

You see how far wrong we can be in our opinion as to where business can come from. This section of the city was taken away from this man and placed in the hands of another man, who believed the figures we gave him about the potential possibilities of the territory and employed two salesmen to help him get the business which he did.

While sales analysis is a big part of market analysis, it is not all of it. Some kinds of market problems cannot be solved by figures. Figures may not be avoidable and perhaps the problem cannot be reduced to terms of figures. In this case the "field investigation" is resorted to. This is quite a tool for market analysts and they employ it to decide many questions. I have in mind one concern whose business started to decline and continued to do so. They had no idea what caused it, their Sales Department could not offer any reason except that the article was priced too high, the usual complaint from sales departments. They resorted to a field investigation. About forty calls were made in two weeks time from which two important things were learned (that is not enough calls but the idea was simply to find out what might be causing the decline).

One, the consumers of the product had begun to discount the value of the product. They admitted that it was an excellent piece of merchandise, but they would not admit that economically it was the best thing they could use, which is the very thing this company had been preaching for years. They had attempted to show and did show for a great many years that it was economy for the farmer to buy their high priced goods and now their customers were slipping away from them using lower priced substitute goods.

Two, they found a new form of competition had come into the picture and was meeting with very good success. Therefore, this company as a result of this survey knew in what direction to strengthen their sales arguments and learned how to rearrange their advertising to meet a new condition. They may even have the good sense to change their product so as to minimize the opposition of their

ambitious competitors. On the other hand they may be victims of that sense of superiority so many leaders in industry have where they feel themselves above following in the footsteps of a small competitor who has conceived a bright idea and is making good on it. It took one concern five years to wake up and bring out a product like a small competitor, but by the end of that time the small competitor had grown big and was making himself a factor in the trade.

If you have heard anything at all about field surveys you have heard that it is the practice to send out crews of men, six or seven, into all parts of the country, armed with a certain manner of approach and intent on getting certain specific information. This is still the practice but when these men turn in their reports there is so much to read and digest that it often develops that the people interested haven't the time to read the extensive report and the full benefits are not realized. I have heard some people depreciate the value of this kind of a field survey. A better way, I think, is to send out one man and have him get the facts and instead of asking him to make a report, ask him to interpret his findings and suggest a plan of procedure to carry out needed objectives.

There is a certain part of Canada where sales of automobiles and luxuries lag behind the rest of the Dominion. Those people do not buy half the cars that they should, based on what the rest of the Dominion is buying. One automobile manufacturer wanted to know why and he sent out an investigator. It resolved itself immediately into a study of the French Canadian, his customs, habits, desires and how he spends his time. The influence of the climate was reported on, the scarcity of garages, the low wage scale, and other important side lights. This all made a wonderfully instructive report and while the information was valuable, nevertheless, they wanted the investigator to go further and lay out a plan of procedure and decide what should be done, along advertising lines, to awaken the desire to buy more motor cars and particularly of their own make. This was done. Their advertising in the territory this year will be quite different from what it would have been without the survey. This is the test of a field survey and out of it can be evolved a better sale plan, an improved advertising plan. It very often results in a change in the product; another article may be added to the line or one taken out of the line; specifications and formulas may be changed in accordance with the findings of the survey.

There is one other market analysis tool which is used frequently and that is the questionnaire. When you need to know the concensus of opinion regarding some idea, you might send out several thousand questionnaires. The questions can be framed in such a way that what you seek to know may be gained quickly and at little expense. One company recently spent $8,000 to mail out questionnaires to 100,000 individuals in an effort to find out what make of automobile they would buy next. They received replies from 22,000, which is a good percentage. Only forty-five per cent of the owners of one popular priced car said they were going to buy another. Eighty-six per cent of the Buick owners said they would buy another Buick. Just see what a position this puts Buick in. They recognize that their owners make up a veritable army of boosters. They will be sure to keep this feeling alive with the proper kind of advertising. They know their product is right or people wouldn't want to buy again and again.

Now, where and how does all this concern the crushed stone manufacturers' of America? Perhaps in no way, and then again, maybe you wanted something on market analysis. I have given you an outline of the framework of market analysis.

First, I mentioned figures, or rather sales analysis; statistical data.

Second, the personal or field investigation.

Third, the written questionnaire. You are interested in sales, production, and costs of distribution. As a group and individually you would like to have more sales, larger production and lower costs of distribution. You can get some help on these problems through the use of market analysis. You could map the country and show every possible source of business and what its volume runs. You could show every point of production and the costs of reaching surrounding markets and the costs of reaching far away markets. You might zone the country and then break up each zone into states and possibly counties and show what is in these smaller territories which would be of interest to you either as a source of business or a source of supply.

You might in seeking new applications of your products, secure the aid of a chemical research laboratory to find new uses for your raw materials. You might like to have visualized before you all the present uses to which your materials are put with a view to studying each carefully to see if there is anything you can do to better the finished product. You have other ideas for the promotion of your business and I hope that this talk on market analysis has given you enough information so that you can determine if market analysis can be of assistance to you in achieving the ends you seek.

Building Blocks

Molded articles such as bricks, tiles, slabs, heat or electric insulators and the like are made from a composition consisting of gypsum cement, an aggregate and coloring material. Portland cement and non-conduction materials such as asbestos may also be added. As a typical example, 90 parts of gypsum cement, 300 parts of sand and coloring matter as required.

VALUE OF INDUSTRIAL ASSOCIATIONS

By G. S. Brown
President, Portland Cement Association*

EVERY industry has many problems coming up which are common to all individuals and corporations engaged in it. Many of these can be better solved through cooperative, rather than individual, effort. Indeed, many of them are frequently impossible of solution by an individual because of the cost or inability to obtain expert advice. The Industrial Association provides a practical and economical method of attack under such conditions. To illustrate—unscrupulous manufacturers may, and often do, indulge in unethical business practices or ship material of questionable quality. Such action is, of course, detrimental to the interests of the reputable manufacturers. Unscrupulous buyers may and often do impose conditions upon the manufacturer which ultimately would be ruinous. The Industrial Association may profitably endeavor to remedy such conditions. Again, the experience of one manufacturer or producer in certain directions, if compared with that of others in the same industry may, and often does, result in the advantage of all manufacturers or producers and of the general consuming public as well. Such problems as those involving the use of labor, methods and machinery, the study and prevention of accidents, and the study of cost and type of insurance against the various risks of the industry, may profitably and legally be handled by the Industrial Association.

In addition to the intense and sometimes vicious competition that prevails among the members of an industry there has arisen in recent years a different competition, which has been called by some publicists "the new competition." This, I call the competition between industries. Perhaps it could more rightly be called "competition between materials which may be substituted for each other." In passing I may say it seems to me this competition between industries, or between substituting materials, if not already, will soon be more effective in protecting the public as to price and quality than the anti-trust laws and statutes referring to quality have been in all the years these have functioned.

To me the competition between industries or between material substituted for each other is so widespread and of such a nature that it is doing more to protect the public from the evils, that were supposed to be overcome by the Sherman Trust Law, than all of the trust legislation and all of the quality laws that provide for quality on the statute books, of all our government books, national, state or municipal. That competition protects the public from price. If you gentlemen raise the price of gravel to such a point that the crushed stone man can come in, he substitutes your material. You have to keep your price down to compete with substituting material. We in the cement industry build roads that cost a certain amount. If we raise the price of our production to the point where it is cheaper to build a brick road or an asphalt road on cement foundation, we lose that market. It is taken away from us. Substitution material takes it. I mention these to show you how this competition between substituting materials will protect the public as to price and quality.

The Industrial Association is peculiarly fitted, particularly in those industries producing material for which other material may be substituted, to promote in every legitimate way the use of its own particular product. The value of cooperative effort is emphasized where the material is standardized as to quality. In such cases the material produced by one manufacturer is not essentially different, in use, than is produced by other manufacturers in the same industry. Consequently the material may be advertised by the association instead of by individual operators with unusual savings in such expenditure.

In most industries there are peculiar problems frequently requiring the use of expensive and special machinery and of trained and expert minds in their solution. There may be required also laborious research and extensive experiment. The Industrial Association is an available vehicle through which such problems may be solved without the expenditure of an unreasonable amount of money. While the basic principles of accounting are essentially the same for all industry and trade, there do arise in every industry problems in connection with the determination of the cost of its product: such as the proper and reasonable amount of depreciation to be applied, the nature and extent of obsolescence occurring and the application of these basic laws to the particular industry. Methods for the efficient handling of such matters can best be formulated and promulgated through the Industrial Association.

The collection of statistics showing production, shipments, and stocks and those showing possible future demand, is a legitimate and valuable work of the Industrial Association. While this activity (the collection of statistics) has been the genesis, and in many instances the only work of Industrial Associations, it has become, in my judgment, a minor activity for the better organized associations.

In most of the illustrations used I have stressed the economy effected by cooperative effort through

*Presented before the Eleventh Annual Convention of the National Sand and Gravel Association, January 18th, 1927.

the industrial association. There is another value of association effort, difficult to express in dollars and cents; it is the value of sustained effort. We know the value of continuous effort along the line of increasing and cheapening production. We know the value of constant watchfulness and zeal on the commercial side of our business—but specific problems are likely to be considered at irregular periods. Those in charge of a particular property have many duties in connection with the necessary detail of routine operation. Consideration of such topics as I have referred to as examples of profitable association work are passed by on occasions when they are considered with the thought that some time they will be taken up seriously; or that having gotten along fairly well so far they perhaps are not so important anyway. These special problems, however, when referred to an association for solution, become to it items of major importance. The success of those in charge is judged by success in improving conditions. Some startling results have been brought about through sustained effort on the part of the Portland Cement Association along particular lines.

The Portland Cement Association came into being in 1915 through the reorganization of the Association of American Portland Cement Manufacturers. The latter organization was formed by a small group of Eastern manufacturers in 1902 because changing conditions in the industry had brought about a problem incapable of individual solution. When the Portland cement industry had its origin in the United States the product following the custom of European manufacturers, was shipped in wooden barrels. This container was expensive and had in many places no salvage value, making the cost of cement much higher than it would otherwise have been, thus being a wasteful method of shipping. Somewhere about 1890 to 1895 the industry began to substitute cotton sacks as containers in preference to the wooden barrel. These sacks could be returned and used again a number of times. Abuses in the handling of these sacks speedily crept in, threatening to destroy all the saving their use was intended to bring about. The problem was not easy of solution and indeed it may be said that the handling of cotton sacks today is one of the great annoyances of the Portland cement industry. However, in the course of a few years a condition was brought about whereby the saving intended was secured.

The association in those early days had but little income. It had $1800 its first year. Eight years later, in 1910, the income had increased to nearly $25,000 per year. In the meantime it had begun the collection of statistics and was groping about for some way to increase the use of cement since the possible production of cement had increased at a more rapid rate than had consumption. The price received was in many cases less than cost, so manufacturers began to think of economies whereby cost could be reduced without jeopardizing quality. Thus the attention of the association was turned towards promotion and research. To the present time these have been its main activities.

About 1909 Edward N. Hines, County Commissioner of Wayne County, Michigan, built his first cement concrete road and between that date and 1915 small stretches of this type of pavement had been laid in various parts of the country, but particularly near Detroit and Milwaukee. The industry was satisfied that its dream of a great network of concrete paved highways throughout the country would become a reality if the people could be educated to the advantage of this type of hard surfaced road. To do this through individual effort involved much duplication and great expense, so it was determined to enlarge the scope of the association, increase the dues and enter upon a campaign of intensive and continuous promotion for the use of Portland cement concrete as the best and most satisfactory pavement for highways. Sustained effort has made the development of the concrete highway the outstanding success of the Portland Cement Association. One-quarter of the Portland cement produced in the United States today goes into the manufacture of cement concrete highways, streets and alleys. However, we do not feel that we have as yet adequately covered the field and confidently anticipate a still larger proportion of our product will be used in this field.

The cement industry had a very bad accident record. A Bureau of Accident Prevention in the Association was organized and it began to work with the manufacturers for the reduction of accidents. For a number of years this work met with indifferent success. However, sustained effort brought the usual result, so that today the Federal Government holds up the association as a model in the work of accident prevention. In 1922 a trophy was provided to be awarded to that mill of the membership of the association which had the best accident prevention report for the calendar year of 1923. Only one trophy was provided, because the membership in the association did not have faith in what could be done. The trophy was awarded in 1923 and 1924 to mills which had a very good accident record, but in 1925 there were two mills which went through the year without any lost time accidents. The membership of the association felt that a mill which could make a perfect score was entitled to a trophy, and so two were provided in 1925. In 1926 there were also two mills without lost time accidents and we are now looking forward to the day when we will have to award not two trophies but a number of them each year.

During the war the cost of Portland cement increased very greatly and some of the members of our association felt that unless the price to the consuming public could be kept down, we might lose considerable of the ground that we had gained. Wages were very high and labor difficult to get. It

was suggested that some of the cement plants were manufacturing their cement with very much less labor than others and that a comparison of the use of labor might be of assistance, so a large percentage of the membership reported their use of labor for the year 1919. These statistics have been continued until the present time. The use of labor to manufacture one thousand barrels of Portland cement in 1920 was 39 per cent more than the use in 1925. You gentlemen who deal with labor will appreciate what a saving in cost and trouble there was in the industry in a reduction of that character, brought about through the activity of the association.

Thus far my comments have related to what we might call the selfish value of an industrial association; that is to say, its value to its members. We in the Portland Cement Association have developed the thought that we can be of material service to the public as well. We think that our development of the concrete highway and street has been of distinct advantage to the public as well as to ourselves, but we have gone much further. The association has in its building in Chicago the largest research laboratory for the study of concrete in the world. In it the behavior of cement in its various uses is critically studied and from time to time discoveries have been made which have resulted in material savings to the users of cement. By the way, I suppose most of you know that our association two or three years ago began the construction of a building in the city of Chicago. That building is our headquarters and three floors of the six, counting the basement, are devoted to the work of research laboratory. The study in this laboratory is continuously devoted to improving the quality of concrete. As we obtain information it is printed in booklets and set out to the public, and some of the results have reduced the cost of making concrete very greatly.

Quality of the product is a basic principle in any industry. The trade association should be the center of progressive movement in the industry itself, and we were very glad when the time came that we could put in our constitution a paragraph which made membership contingent on producing cement of high quality. This provision has been, we believe, of immeasurable benefit to the industry and to the public as well. It is of prime importance for the protection of the small user who cannot have his cement tested by a commercial laboratory. I might go on and enlarge on the activities of the Portland Cement Association and the value of these activities either to the industry itself, or the public. I am sure, however, that enough examples have been given you to convince you without any mental reservation that the trade association may give in direct benefit to its membership more than value received and this without consideration of the indirect benefit that comes to the industry through the service which is rendered to the public.

I hope that this short review of the history and accomplishments of the Portland Cement Association will encourage you in the support of your own association and bring to you the support of many of those in your industry not now members. Many of your problems are doubtless different from ours. But you should educate the public to the great value of your product. Where and when educated the good will of the public must be kept. Nothing you can do will help in this effort more than to insure to the public high quality. You are unfortunate in the fact that your product cannot be branded. Your material is sold in bulk and you have no container on which to print your message. Cement shows its identity on the sack, so does lime, lumber is being stamped with the producer's name, and practically everything else in the building line is branded. Some means may be found in your research work whereby a fair specification can be evolved. Then you will be in a position to advertise to the public a material of certain minimum specifications, you will be in a position where membership in your organization, based upon quality of product, will insure good will from the purchasing public and a larger business to your membership.

From my viewpoint, the officers of an association, be they ever so capable, cannot produce success. The paid personnel, no matter how competent, cannot do it. The membership, no matter how large or interested, cannot do it, but active officers, loyal and zealous workers, and an enthusiastic membership working in hearty cooperation and full harmony, will bring unqualified success. That you may have such officers, workers and membership is my earnest wish.

New Ship Called "B. F. Affleck"

A new 600-foot steamship, "B. F. Affleck," is now being built for the Pittsburgh Steamship Company to be used in the iron ore, limestone and coal trade on the Great Lakes. This modern 10,000-ton steel freighter under construction at Toledo is one of two ships that are being added to the Pittsburgh Steamship Company's fleet. It is named for Benjamin Franklin Affleck, president of the Universal Portland Cement Company, a United States Steel Corporation subsidiary, with plants at Chicago, Pittsburgh and Duluth.

Enlargement of lake-carrying service is in line with other recent activities of the Universal Company which is just completing a three-million-dollar expansion program at its Chicago (Buffington, Ind.) plant, which includes construction of a new harbor, dock, storage yard and lighthouse. This development will make possible shipments by boat of finished cement to all lake ports as well as expeditious receipt of raw material from quarries.

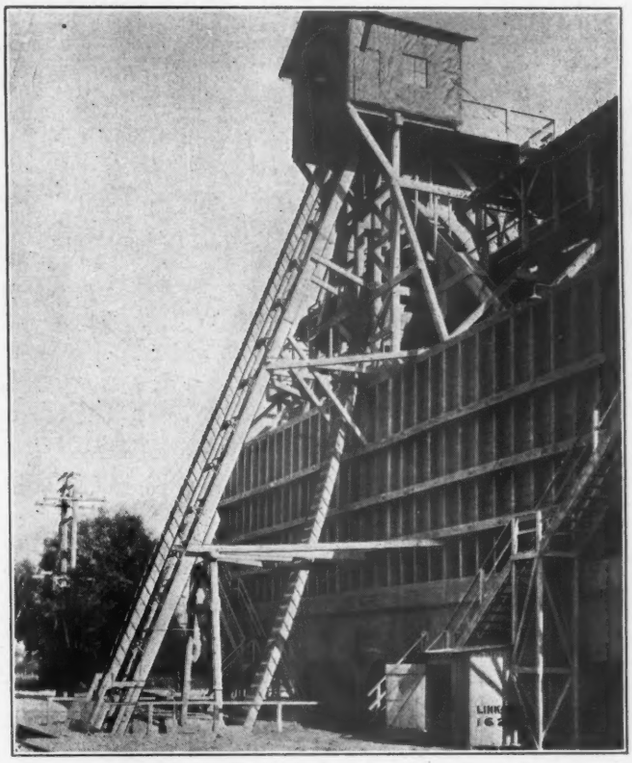
UNION ROCK MATERIAL HANDLING SYSTEM SPEEDS UP DELIVERY TO JOB

By T. V. Hawkins

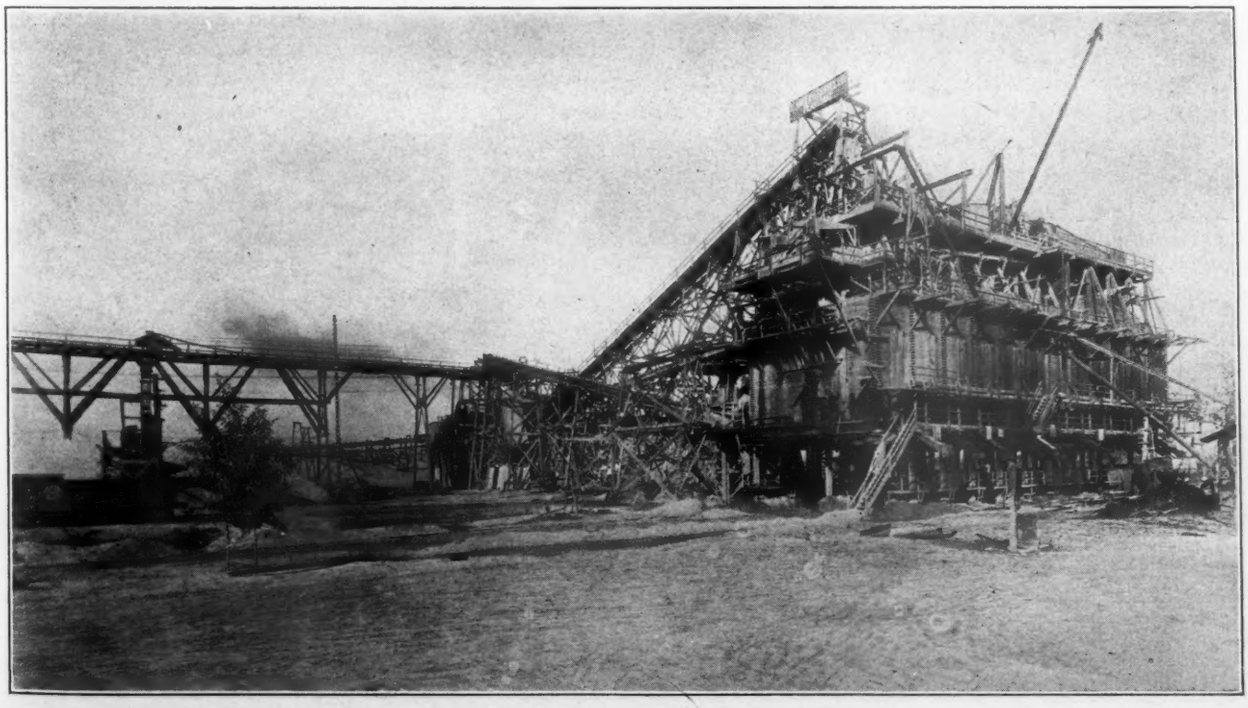
THE Link-Belt Meese & Gottfried Company (owned and operated by Link-Belt Company), has recently supplied the elevating and conveying machinery and silent chain for distributing bunkers for the Union Rock Company of Axusa, California, which has been instrumental in economical production. These rock bunkers are used to receive and store sand, rock and gravel of various sizes, usually not only to suit the building and heavy construction trade, but also the large paving jobs.

Each of their bunkers has a storage capacity of from 4000 to 4500 tons, and are of the latest type construction of concrete and heavy timbers, equipped with elevating and conveying machinery. They are used to receive material by rail from main plants at the various rock and gravel deposits, and to store for motor truck short haul delivery.

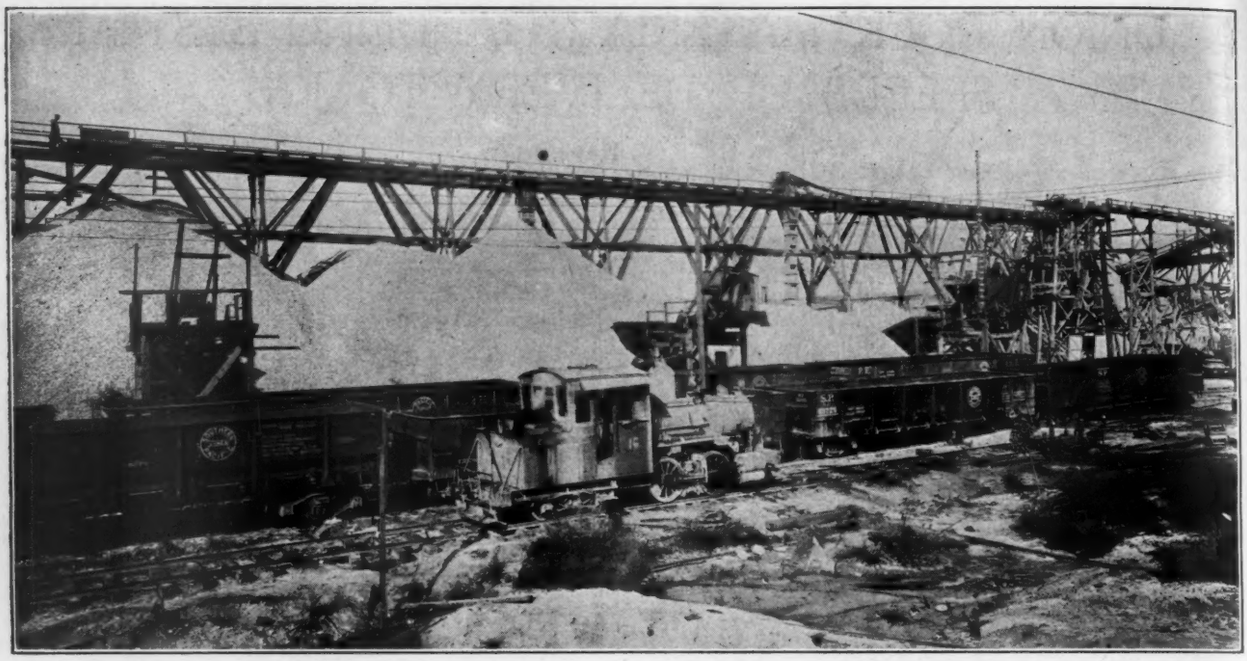
The Sherman bunkers are located at Sherman, California, which is the distributing point for Beverly Hills and beach cities. The Los Nietos bunkers are situated on the Santa Fe Railroad, near Los Nietos. This is the distributing point for the cities of Whittier and Riviera, as well as the Santa Fe Springs oil fields and the Norwalk and Artesia districts of Los Angeles County. The Merril Avenue bunker, on the Pacific Electric Railroad, at Merril and Compton Streets, Los Angeles, serves as a distributing point for the Southeast Los Angeles section, the Union Rock Stockyards industrial district, Huntington Park City, in the Goodyear Industrial section and in the city of Watts, California. Compton, a midway city on the Southern Pacific Railroad, between the metropolitan dis-



View of Continuous Elevator at Los Nietos Bunker



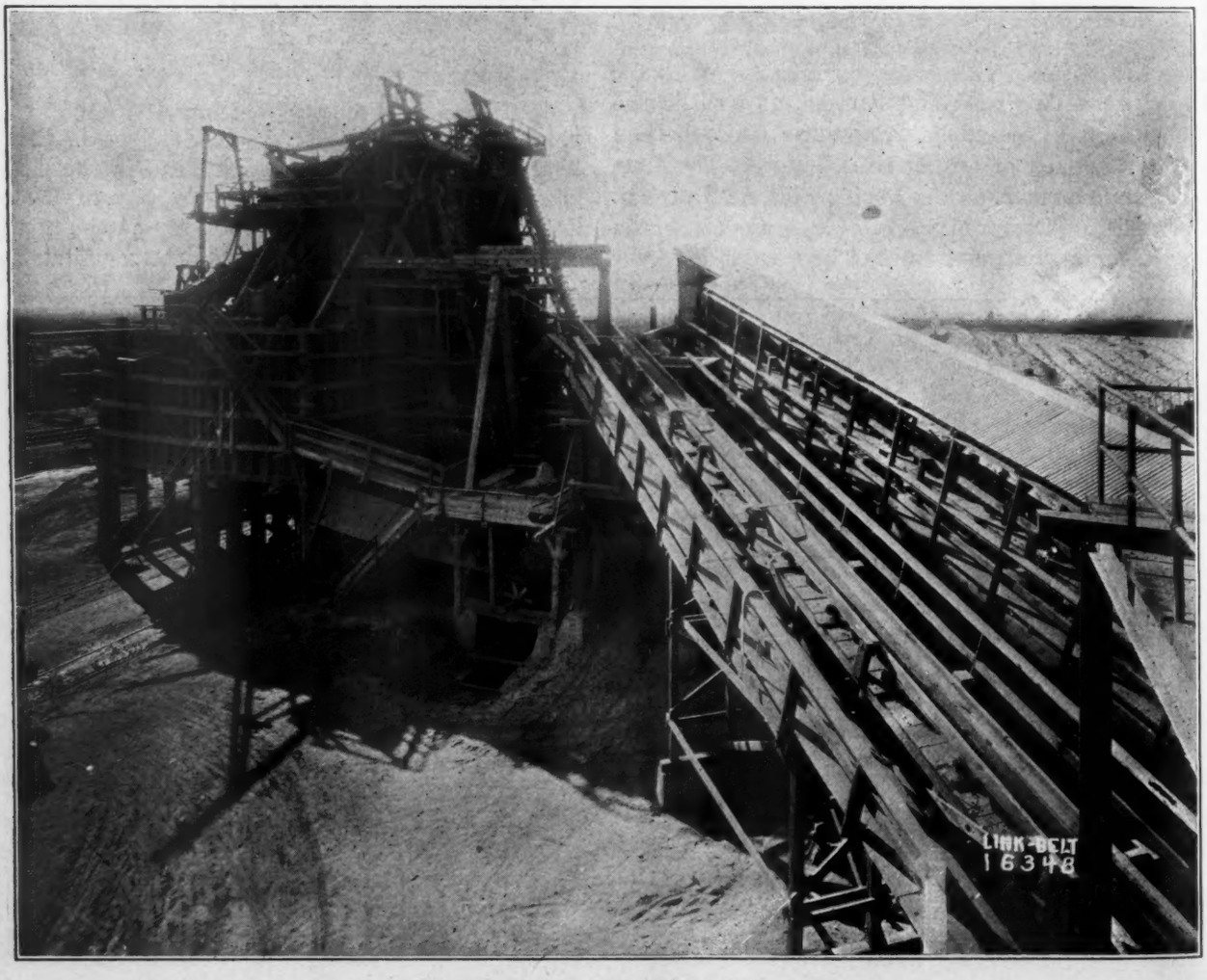
General View of Storage System at Durbin Plant



Trestle Supporting Conveyor Leading to Storage at Durbin Plant

trict of Los Angeles and its harbor serving the Compton, Lynwood and Watts section, and the Dominguez and Athens oil fields, is the point at which is located the Compton bunker.

With the use of the elevating equipment at these bunkers, the cars are unloaded very rapidly into the bins, 10 minutes being sufficient time for the unloading of a 50-ton car, and elevating the mate-



View of Conveyor System and One of the Bunkers

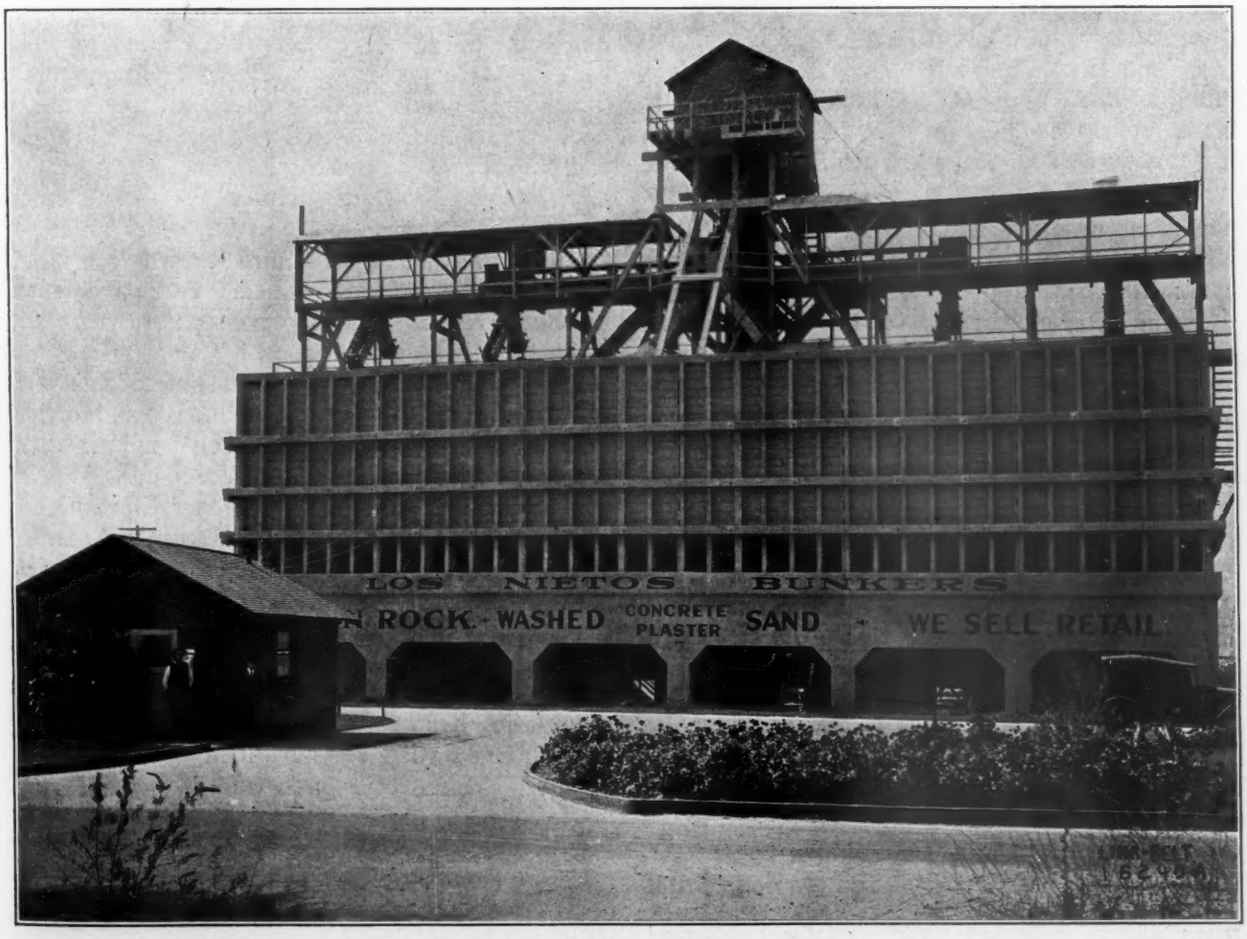
rial therefrom into bunkers. All elevators at these bunkers are of the continuous type, with a 30 inch bucket on a 32 inch ten-ply elevator belt, and are driven by a 75 h. p. motor. The elevators are all automatically controlled with push button controls, located at different points around the bunkers.

The Los Nietos and Merrill Avenue bunkers have a 30 inch shuttle distributing conveyor on top of the bunkers, for distributing the different sizes of material into the different bins. The two shuttle conveyors are direct-driven by Link-Belt silent chain. All the other bunkers above mentioned are equipped with 30 inch stationary belt conveyors. The height of the elevators at the bunkers ranges from 90 foot to 100 foot centers.

One of the illustrations shows a general view of the new storage system at the Durbin plant located at Baldwin Park. This storage system at the present time is only about half completed and when it is completed, it will be approximately 750 ft. long. The belt on top of the trestle, which is 60 feet high from the ground, is a 30 inch conveyor belt, equipped with a Link-Belt Meese & Gottfried self-propelled high frame type tripper. The material is deposited over the different tunnels along the storage system by the tripper. In each tunnel is a 24 inch belt conveyor with 125 foot centers, which loads the material into the cars. At the present time, there are five tunnels. The belts are wider than usual in most storage systems, and with wide belts this allows very quick loading into the cars.

This plant was formerly owned by the Los Angeles Rock and Gravel Company. The Union Rock Company purchased this plant about two years ago, and since that time has added this new storage system. The plant has a capacity of approximately 3,000 tons of material per hour.. The new conveyors installed recently at the Kincaid plant located at Azusa are 30 inch belt conveyors that take the material from a crusher up to the mills. One conveyor is used for taking the material coming from the crusher, and the other conveyor is used for taking the sand and gravel which does not go through the crusher up to the mills.

The reciprocating feeder is a 30 inch heavy type and has a 1 inch plate on the bottom and a ½ inch wearing plate. This feeder is driven by a Link-Belt SS-40 chain from a cast steel jaw clutch, keyed to the tail shaft of the conveyor. This feeder has a capacity of 250 tons to 300 tons per hour. It has proven to be a real feeder, and has given very satisfactory service since it has been installed. The Union Rock Company has found these bunkers especially useful, in that they have assisted materially in saving time for railroad cars to return to the plants.



Distributing Rock Bunker at Los Nietos

CONSTRUCTION AND MAINTENANCE PROGRESS IN BITUMINOUS ROADS

By K. E. McConnaughay
Hayes Construction Company*

BITUMINOUS macadam pavements and modifications of the type have progressed steadily in the State of Indiana during the past five years. The mileage has more than doubled and the quality of the work is much better than that constructed in the past. This new interest has caused engineers, officials and contractors to take note of the possibilities of this type of work and to that end, several experiments have been conducted, some of which will be set out in this discussion.

Preparation of the subgrade, or of the old surface has received the attention necessary. On new construction in many places a layer of stone, gravel or cinders has been used to reduce the capillarity of the sub soil. Where the macadam has been placed on an old base, this base has been carefully brought to a true grade and crown, either by a waterbound course or by a layer of black base. In shaping up an old base, grade stakes are set and all turns are carefully treated for super elevation. Care has been taken to flatten the crown of the road and to strengthen the edges. The base of the pavement is usually made six inches wider on each side than the bituminous macadam top course, and this reduces the danger of the edges spalling off or ravelling. The bituminous macadam wearing course, usually three inches in thickness, is constructed so as to have sturdiness and little danger of shoving.

The stone used is a size passing a four inch and retained on a two and one-half inch circular ring, the resulting size stone averages three to three and one-half inches, the keystone is a size passing a one and one-half inch and retained on a three-quarter inch circular opening, the screenings are seven-eighths to three-eighths inch in size, all of the stone is sturdy in size, and with the binder holding the aggregate together a rugged pavement is obtained.

The binder used is much heavier than that used in the past years, asphalt especially has dropped in the past five years, from an allowable penetration of 100 to 120 to a penetration of 80 to 95 and the amount of binder used is approximately fifteen per cent less. Reducing the quantity of the binder has greatly reduced the tendency to wave and bleed during the warm weather. Bituminous macadam is now constructed in such a way that three or four applications of binder are necessary, the penetration course to bind the large stone, the second application to seal the keystone and the double seal coat of cold material to remove small surface irregularities. The bituminous material used in the double seal is of such a nature that it can be handled easily at least five hours after application. Cold tar similar to Tarvia "B" and the state specification for the tar TM are used, if asphalt is used it is a cut back product, made from a base of approximately the same asphalt as that used in the penetration course. This specification is covered by state specification for asphalt A.C. or B.C. both grades having about 20 to 30 per cent of distallate as a solvent.

After the pavement has been treated with the first two applications of binder and rolled thoroughly, the surface is tested with an eighteen foot straight edge and any defect over one-half inch in depth is removed by filling that spot with a lean mixture of stone and cut back asphalt or cut back tar. After the surface has been constructed in this way, a light application of the cold bituminous material is made and this is covered with stone screenings in the amount of about twenty-five pounds per square yard. This application of binder and stone is then dragged with a twenty foot base drag, nine to ten foot wide, and having approximately six blades with opening at the lower or back end of each blade. The stone and binder are thoroughly mixed, and the mixture is dragged into any minor depressions. When necessary a second application of the stone and binder is made and the dragging is continued until the surface is true and until the voids are filled. The pavement is finished by rolling on five consecutive days with a ten ton, three wheel roller.

The riding qualities and appearance of this pavement, to say nothing of the stability, has increased twenty per cent over the past construction in this state, and it is quite evident that more progress will be made in the next five years than in those past. As evidence of what progress may be expected along these lines is the growing interest in penetration black base. Some of this type has been constructed three miles of two course base finished with a retread top, and one mile of two course base under bituminous concrete. The State Highway commission has experimented with a layer of black base finished with one-half inch of rock asphalt over an old concrete base, and in several cases, black base has been constructed with the expectation of adding another layer of the same type when traffic so demands; in these cases allowance for the next course has been made in establishing the grade of the first course of pavement.

*Presented before the Tenth Annual Convention of the National Crushed Stone Association, January 18th, 1927.

In constructing black base the same general methods are used as in the bituminous macadam top course. Large stone four inch to two and one-half inch in size is used, the surface of each course is tightly keyed and given a second application, and any depression occurring in either course of base is removed by hot penetration or cold mix patching. The binder used in black base construction is of the same quality as that used in the surface course, but the quantity should be about one and one-half gallons for each course. This gallonage must be increased for work in cold weather. Grade stakes are set, and form boards or steel forms are used for each course of base.

Penetration black base is substantial, adaptable to most sub-base conditions and can be constructed with less loss of time than any other type of base. From the standpoint of the taxpayer, there is no question as to the economy and owing to the speed possible in construction, property owners along the road are inconvenienced as little as possible. The contractor is also benefitted, because the same organization and equipment can be used in the base construction as in the top and no time need be lost for curing of one course before the next can be placed.

The state of Indiana is very fortunate in that it has a great mileage of good gravel and stone roads, and in the state system alone about 2800 miles are maintained as gravel and stone roads. In many cases these roads are serving very well, but quite often traffic is such that it is almost impossible to maintain these roads by merely adding material and dragging. There is breaking up in the spring, chatter bumps and dust during the summer season. The state and counties have looked for type of resurfacing that would cover a large mileage at low cost and the most economical way to accomplish this end seemed to be surface treatment with light bituminous material. Several gravel and stone roads were treated with light cold bituminous materials, and the results were very good. The chief objection was that after several applications the surface would have an excess of bituminous material, and this would lead to waving and shoving under the traffic.

The state of Indiana has become interested in a more stable treatment for the old macadam roads, and several samples of this work have been done during 1926. The thickness of the treatments range from three-quarters inch to one and one-half inch, and in the county work, the treatment has been constructed to a depth of as much as two and one-half inch. This work has been called retread. The first work in Indiana known to the writer is in the entrance to Crown Hill Cemetery at Indianapolis. It was placed in the spring of 1923 and by the following method.

The old base was gravel and stone about eight inches thick, well drained and with a brick gutter on each side. The area covered was about 2,000 square yards. The old base was swept clean and an application of binder was made, using asphalt A-2 (85 to 100 penetration) mixed with a small percentage of tar TC; the quantity of the application was about 0.4 gallon per square yard. The entire surface was then covered with limestone dust to a depth of about one-quarter inch; the bituminous material came through this layer of dust, and the surface was covered with limestone screenings, size three-quarters inch to one-quarter inch. There were considerable voids in the surface, so the entire pavement was covered with sharp sand or grits even with the top of the chips. The surface was not rolled and was opened to traffic immediately after the covering with the sand. For about two weeks the surface was soft and bled a good deal, but not so much as to allow picking up under traffic. The top was about one-half inch to three-quarters inch thickness, had a hard finish and had not needed patching or maintenance until 1926. The surface was given a light tar treatment this year as a safeguard, because there was some indication of cracking which might become dangerous during the next spring.

The next piece of work of this nature was done in Marion County; the work was finished May 29, 1926, and is on the west and north sides of the Indianapolis Motor Speedway. It was necessary to place some kind of a surface on this road to take care of the tremendous traffic attending the annual five hundred mile race. The old gravel base was reshaped by scarifying and grading and a layer of stone was placed, about two inches in depth. The size of this stone was one and three-quarters inch to one inch clean and free from dust. The stone was spread with a road grader and maintainer having two blades. After the desired surface was obtained, the first application of tar was made, the amount was about one and three-quarters gallons per square yard. Immediately after the application, the grader and maintainers started to drag the surface, being careful not to drag any of the old gravel or dirt up from the base. No attempt was made to mix the tar and stone on this piece of work. After the tar had dried out to a point where it could no longer be easily handled, the voids were filled with limestone chips, size three-quarters inch to one-quarter inch and another application of tar was made. The last application of tar was light but varied according to the depth of stone; the road was dragged thoroughly and rolled until solid.

This road is solid, has had both heavy and fast traffic, and the day after completion was subjected to the Speedway Day traffic which was as much as some roads have over a six month period of time. The road has not had surface failures, but in a few places the base did not hold up and depressions formed which can be easily removed in the

spring with a cold patch mixture of stone and cut back tar or cut back asphalt. The tar used in this work was tar TM and tar TH. The cold tar TM had a specific viscosity of thirty to forty-five The hot tar TH had a float test of sixty to one hundred and twenty at 32 degrees C. Where the hot tar TH was used, it was necessary to complete the dragging within thirty minutes after the application, but this work moved along with more speed than where the cold tar was used and the results are much more substantial.

The Indiana State Highway Commission placed a mile of this type on State Road number 36 west of Danville, Indiana. This work was done in the following manner: The old stone was reshaped by dragging and grading and an earth hem was thrown up on each side of the road. The surface was covered with a layer of stone about three-quarters inch to one and one-half inches in depth. The stone used was about one and three-quarters inches in size, and the old surface of the road was not clean; there was quite an accumulation of dust beneath the clean stone. The first application of one-half gallon per square yard was made on the loose stone. After the full width of the road had been covered, the stone and asphalt were scraped to one side of the road, leaving a bare strip about ten feet wide. This strip was next treated with about 0.33 gallons per square yard, and the operation was reversed, throwing all the metal and asphalt on the treated space and treating the remainder of the base surface.

The mix of asphalt and stone was then spread out evenly over the road, and the entire surface was rolled and dragged until smooth and solid. The road resembled an open mix asphaltic concrete at this point and was allowed to stand for about twelve hours; in this time the solvent evaporated out of the mix. The voids were filled with three-quarter inch to one-quarter inch stone chips, and the surface was covered with an application of asphalt, about 0.25 gallons per square yard, and the road was then dragged and rolled until no movement was shown ahead of the roller wheels. From time to time, it was necessary to add a small amount of covering material, and the road was covered lightly with three-quarter inch to one-quarter inch chips before it was opened to traffic. The asphalt used on this section was asphalt A.C. made from an asphalt base of 85 to 100 penetration and having about 25 per cent of distillate for a solvent.

The Indiana State Highway Commission constructed another retread section east of Bedford, Indiana, and in this case the stone used was two and one-half inches to one and one-half inches and was about two inches deep. More binder was used and about 25 per cent solvent. Retread may answer a need for a pavement between the surface treatment and bituminous macadam and has already been used to resurface sheet asphalt and old bituminous macadam. In localities where a small sum of money is available each year, it is possible to plan and construct a progressive system of paving in which a retread top can be added when necessary. In this system the investment is distributed, and there is not so much danger of over-financing any one particular unit in a community.

Purchase Value of Dollar Fluctuates Only Five Percent in Five Years

During the last five years, the purchasing value of the dollar has fluctuated little more than 5 per cent when measured by living costs of the American wage earner according to a report of the National Industrial Conference Board. The dollar, on the basis of living costs is now worth about 60 cents as compared with the 1914 dollar. It has fluctuated less than five cents from this value since 1921. The dollar may be considered as having become stabilized at this level when contrasted with the wide fluctuations the first few years after the war.

Average living costs as computed by the conference board during the year 1926 were slightly (1.8 per cent) lower than in 1925, but in January, 1927, were still 66 per cent higher than in 1914, just before the war. Average weekly wage earnings at the beginning of the current year, however, were 116 per cent higher than, or more than double of what they had been in 1914, leaving the wage earner 28 per cent better off than he had been before the war as regards the purchasing power of his weekly pay.

The most important factor in determining the living costs of people of moderate means is food, expenditures for food representing about 40 per cent or more of the wage earner's necessary living expenses. Following a rise throughout the last four months in 1926, living costs in January of the current year again resumed the downward tendency which had been under way ever since November, 1925. This was the result chiefly of a decline of nearly 2 per cent in retail food prices from December to January.

Wholesale commodity prices are again about at the low level reached in 1921, after a fairly steady decline since August, 1925. The rapid decline in the price of farm products has been the chief factor in the decline of wholesale commodity prices which began in the middle of 1925, but it failed to have a proportionate effect on retail food prices, the gap between wholesale and retail food prices having shown a tendency to widen since the summer of 1926, according to the conference board.

SCREENING PLANT DESIGN DEVELOPMENTS

By Albert E. Reed
W. S. Tyler Company*

ONE prominent authority has said that the revolving screen or trommel has held first place in the industry not because it was a good sizer but rather because it was a good washer. It is a significant fact that in every industry as soon as the importance of sizing became recognized, the trommel has been discarded. The first great industry to do this thoroughly and completely was the mining industry. Curiously enough, this industry does not sell its products according to particle size but more efficient screening was forced on them through the necessity of reducing grinding costs.

It was only a few years ago that trommels or reels were the accepted type of screen in the salt industry. They are the exception. These instances are typical of the discarding of the revolving type of screen for more efficient flexible and economical means of sizing.

It is no reflection on the sand and gravel industry that they have not scrapped all their revolving type screens for as pointed out above, they have been faced with a washing as well as a screening problem and the development in washing processes has lagged considerable behind the advance made in screening. In fact, it is to the credit of the sand and gravel industry that during the past five years it has installed as many vibrating screens as any of the larger and more highly capitalized industries.

While we do not have time today to go into all the technical details of modern screening plants, first I will show the fundamental difference between revolving and vibrating screens and then a few examples of modern practice in the design of such plants.

Only one-fourth to one-third of the screening area of a revolving is in use at any one time. Also because of the fact that the opening of a screen is foreshortened according to its angle of inclination from the horizontal, we have in the revolving screen a range of effective openings from maximum at the bottom to zero on the side where the plant is vertical 90 degrees from horizontal. Another unfavorable feature is that the coarse particles tend to run ahead of the fines as the screen revolves, thus blanking the openings making it necessary for the fine material to work its way through the layer of coarse material before it can get down to the screen plant. As a washer or a mixer the revolving screen may still have a place but as a screen or a sizer it is doomed to pass out of the picture. Modern business methods demand and modern engineers are specifying the aggregates by sieve analyses and these two requirements can not be met with in the revolving screen.

Unlike the trommel in the vibrating screen the vibration has a jigging action on the bed of material which segregates the sizes in layers with the finest to the bottom. Those of you who have watched these screens in action know that in many cases the bulk of the fines are showered through in the first foot of screen and the rest of the screen is used to measure the near mesh particles. In the vibrating screen the tendency of the larger lumps or particles to take long jumps and move faster than the fines is a distinct advantage as in this way they are quickly eliminated from the load. It is obvious that if a particle is too large to pass the openings of the screen the quicker it gets off the screening surface the better.

A most efficient type of washed gravel plant is where the feed is elevated by belt conveyor and water is added ahead of the screens. All the screens are equipped with water sprays which washes the material as it travels down the screens. By discharging the sand and gravel into a pit and pumping it to the top of the plant, the gravel can be given more of a scrubbing action than can be obtained solely through the use of sprays and this point is one that should merit consideration in designing a plant.

We sometimes hear the complaint that vibrating screens require too much headroom. However, revolving screens have been replaced with Hummers without increasing the height of their head pulley or decreasing the capacity of their bins. Unless accurate grading of each size is desired, it is not always necessary to use tandem screens. Where a battery of vibrating screens are installed in a washing plant the sprays can be arranged for rinsing the gravel as it travels down the screen.

In a simple type of washing plant the familiar rotary scrubber may be employed at the head of the plant and vibrating screens for making the gravel sizes and separating the sand. With this arrangement any combination of gravel sizes can be mixed together in the bin. In plants where there is much oversize gravel to be crushed, it is advantageous to screen ahead of the crusher and where two stage crushing is employed, between the crushers. The vibrating screen may be mounted on a narrow trestle over open stock piles, and the sand removed at the head of the plant and sent to classifiers. When a vibrating screen is installed on a river dredge it is often possible to place the screens in the available headroom. It is again possible to install a vibrating screen so that it can be

*Presented before the Eleventh Annual Convention of the National Sand and Gravel Association, January 19th, 1927.

used to clean out imperfectly screened material before loading on the barge.

A vibrating screen used in a plant for screening bank sand can be operated by one man. It is built in two sectionalized units, one which includes the screens and the hopper and the other the supporting frame work. The crane can pick up each of these units at a time and carry it to a different part of the pit. Such a plant is primarily used for screening and accumulating a stock pile and is usually found in conjunction with a bin type of loading into trucks. This can also be mounted on bins or on supports. This type can also be built for straddling a track and loading directly into cars and is semi-portable.

It is a generally accepted and recognized fact that the finer the separation, the less efficient is the revolving screen. And therefore the greater the advantage of the vibrating screen. It is not generally known, however, that the vibrating screen has a decided advantage even on the coarser sizes. The following tables show some comparative tests on coarse screening results of rotary, shaker and vibrating screens.

Comparative Tests Between Revolving Screen, High Speed Shaker and Hummer Electric Screens. Oversize of Screens Making 2-Inch Round Hole Separation.

Sieve Size Rd. Hole		Revolving Screen Percent	Cum. Per.	Shaker Screen Percent	Cum. Per.	Hummer Screen Percent	Cum. Per.
2 " Rd		57.7	57.7	69.9	69.9	86.0	86.0
1½" Rd		26.8	84.5	24.6	94.5	12.5	98.5
1¼" Rd		6.0	90.5	3.7	98.2	1.5	100.0
1 " Rd		7.2	97.7	1.7	99.9	.0	100.0
¾" Rd		1.5	99.2	.2	100.1	.0	100.0
½" Rd		.4	99.6	.0	100.1	.0	100.0
½" Rd	Through	.4	100.0	.0	100.1	.0	100.0

Crushed Gravel

4 foot Type 39 tandem Hummer electric screen. Oversize from 1 5/16-inch square mesh screen.

Opening (Rd. Hole Sieves	Test No. 1	Test No. 2	Test No. 3
—1⅜"	78.4%	78.0%	81.0%
—1⅜"—1½"	93.2%	87.2%	90.4%
—1¼"—1 "		97.4%	99.3%
—1 "	100.0%	100.0%	100.0%

As we have seen the vibrating screen lends itself to a simple clean cut design that is a delight to the operator. There are no line shafts, pulleys, belts, chains or sprockets and, there is nothing to lubricate. The power and maintenance is low and the screen cloth consumption per ton is usually negligible. The screens can be supported with a lighter structure than is necessary for heavier moving types and in the case of a new plant we have instances where the saving in the building structure has more than offset the extra first cost of vibrating screens but most important of all and incidentally, the usual reason for their installation, is that the sizing is more accurate and uniform than is possible with revolving screens.

First Symposium on Lime

The Lime Symposium, to be held by the Industrial Section of the American Chemical Society at its Spring meeting, April 11-16, in Richmond, Virginia, holds several papers of particular interest to the pulp and paper industry, as lime is an essential material in either the cooking medium or in the preparation of cooking liquors for pulp production by the sulphite, soda, or sulphate processes as well as in the cooking of straw and rags.

The use of lime in pulp production will be presented by P. A. Paulson, of the Kimberly-Clark Company. Mr. Paulson is well known for his work in the field of pulp and paper technology, particularly in connection with the sulphite process. He is the inventor of a milk-of-lime system for the manufacture of bisulphite liquor which is used by the Kimberly-Clark Company, and among other points of interest to the industry, will be a discussion of the problems connected with the use of both milk-of-lime and limestone systems in the production of sulphite pulp. The papers and discussions will not be limited to the sulphite field, however, as problems connected with the use of lime in the sulphate and soda processes will be considered under the topic of causticazation which is to be presented by W. D. Mount, an authority in that field.

Another paper is one on the open hearth practice of utilizing quicklime for fluxing, to be presented by Dr. D. H. Herty, Jr., of the Pittsburgh station of the Bureau of Mines, who will describe his extensive investigations in open hearth refining. This is at present being done in some parts of the country (among others, in the Birmingham district), and work indicates that substantial benefits may be realized by this practice.

Professor G. I. McLaughlin, of the University of Cincinnati, will present a paper on The Use of Lime in the Leather Industry. Although the leather industry is one of the oldest, developments have come slowly, but recent years have seen a tremendous advance in scientific knowledge and control. These advances will be discussed at this Lime Symposium, as well as subjects of allied interest to leather manufacturers and technologists, such as the slaking of lime, water softening, and the treatment of trade wastes.

Other papers of specific interest will be those on Bleach Production, by A. H. Hooker, of the Hooker Electro-chemical Company; Water Treatment, by C. P. Hoover, Columbus, Ohio, City Water Purification Plant; the Treatment of Trade Wastes, by L. F. Warrick, of the Wisconsin State Board of Health; Lime Hydration, by F. W. Adams, of the Massachusetts Institute of Technology, and Whitewashes for Use Under High Temperature Conditions, by E. P. Arthur, of the Ohio State University.

USE OF CRUSHED STONE AND SCREENINGS IN CONCRETE PRODUCTS MANUFACTURE

By D. M. Allan

Portland Cement Association*

CONCRETE products manufacture has developed very rapidly during the last five to six years. I think one of the most important factors that has aided the development is the general adoption of standard specifications throughout the country for concrete masonry units. We are fortunate, at this time, in having a standard specifications adopted or proposed by the United States Department of Commerce, Building Code Committee; the American Concrete Institute; the Underwriters Laboratories, Inc. and the Building Officials Conference. Fortunately all of these organizations are in agreement in their strength and absorption requirements for concrete masonry units. All require that concrete block and building tile meet a 700 lb. per sq. in. gross area compression test, and that the absorption shall not exceed 10 per cent.

Seven or eight years ago there were no standard specifications in effect and during this short period these specifications have been adopted. In 1920 we estimate that there were about 50,000,000 concrete block and tile manufactured in the United States, and in quoting a few figures that I will give you, I have reduced concrete block, brick and tile to the basis of concrete block, so that I am only mentioning one figure but having in mind the three units. From 50,000,000 in 1920 to about 700,000,000 in 1926 is the growth of that industry. Now what does that mean to the aggregate producers? It requires about 10,000,000 cubic yards of material to make those blocks; or about a quarter of a million carloads of material. I believe crushed stone manufacturers or producers are interested in the concrete products business from two standpoints, a number of them are in the business themselves and a great many are selling screenings and small crushed stone to concrete products manufacturers.

In this discussion I am particularly interested in limestone screenings, and just to be a little more definite I am going to assume that these screenings will be graded about as follows, from five to ten per cent retained on a quarter inch screen and from five to twenty per cent passing a 100 mesh screen. I know that in a good many communities the producers of crushed stone have found the concrete products market a very good one and in other communities producers of crushed stone manufacture concrete products. Sometimes the screenings are used about half and half with ⅜ crushed stone, and in other cases the screenings are mixed with coarse torpedo sand. Limestone screenings in concrete block serve in general to make a lighter colored product which in many markets is considered highly desirable and it serves to make a more workable mix that will stand rougher usage in moving the green product from the machine to the curing room. These two claims have been put forth by the users of crushed stone screenings as their principal advantages.

There is one distinction, I think, that should be borne in mind when considering limestone screenings in the concrete products field as compared with plastic concrete. In plastic concrete there is a tendency for any light fluctuant material to separate in strata or float to the top. In concrete for making masonry units that isn't true for the reason that about 95 per cent of all the products are made by the tamp process. Concrete must be of a rather stiff consistency spoken of commonly as semi-wet. There is no danger, in a mixture of this kind, for this fine material to separate. It remains uniformly distributed throughout the mass.

There are few precautions that have to be taken in consideration when using limestone screenings in concrete products plants. I think, in general, a little longer time of mix is needed when the screenings are used. That is especially true if the screenings are fine. There is a danger, if there is too much fine material in the screenings, that it will ball in the mixer and will not give a uniform mix throughout. So there is a happy medium that must be struck between a mix that is too fat, that will have a tendency to ball, and a mix that is too harsh and have a tendency to break apart when the units are made. I believe that in general a five minute mix should be recommended in concrete products plants, and in the promotion of limestone screenings in concrete products to the manufacturers I believe you should recommend this longer time of mix to insure a uniform quality of concrete. This isn't a hardship because there is a tendency throughout the concrete products field to increase the time of mix.

In some plants they have gone so far as to install two mixers, one above the other. In one the aggregates and cement are mixed dry for five minutes, and are then discharged into the second mixer where they are mixed five minutes wet. It may not be necessary to carry the time of mixing this far, but certainly the five minute mix is worth

*Presented before the Tenth Annual Convention of the National Crushed Stone Association, January 19th, 1927.

while. It is claimed by those who use limestone screenings in the production of concrete masonry that when the tampers fall on the concrete that it is more thoroughly compacted than if the material is too harsh. In this connection, there is a very marked tendency among leading concrete products manufacturers to grade their material in such a way that they can cut the material cost in their product to the very minimum. Frequently it means that manufacturers will get considerably more block from a sack of cement than they do under the present method. The Portland Cement Association has taken a broad gage view of that question. It would seem that when we assist a manufacturer to get twenty block to a sack of cement, where at the present time he is only getting sixteen block, we are promoting in the wrong direction, but the thing we are particularly interested in is to create the most favorable price differential for the concrete masonry materials.

There is a need in leaner mixer for a material in the aggregate that has a plastic, fat, buttery effect. With a harsh aggregate and a lean mix block or tile are likely to be broken when put on a car to go into the steam curing room, webs are likely to crack and the corners fall down. There are two ways to overcome this, one is to use richer mixes and the other is to select the materials that give the fat stickiness desired. It is simply a matter of dollars and cents for the manufacturer to decide which is the cheaper method.

In connection with the making of concrete products, great progress has been made. Machinery for efficient production of block is on the market. Equipment manufacturers are spending much time and research developing more efficient equipment, which in turn is attracting progressive, high grade products manufacturers into the business. I had occasion, a few years ago, to make a trip through New York State inspecting the various concrete products plants as I came to them in each town. I visited 453 plants. In that bunch I found only five power equipped plants. At the present time if one would take the same trip he would have a hard time finding five hand tamp outfits. One manufacturer sold $1,000,000 worth of concrete products machinery last year and not a single hand machine was included. In five or six years' time the business has gotten away from hand machinery and is now in a class where power equipment is used almost universally.

Another indication of progress is the number of consolidations of small plants into large and efficient ones. In the City of Detroit there was recently perfected a large consolidation, and in Pittsburgh another. Five or six of the companies formed a million dollar concern. The new company will have an annual output of 8,000,000 block. Bigger and more efficient plants in the hands of better business men are lowering costs of production and are laying the proper amount of emphasis on sales organizations.

In certain sections of the country concrete products plants have been closed down because they were unable to meet competition. This has forced home the importance of efficient equipment and materials and has resulted in complete revamping of plants and proportions of aggregates. New plants are nearly all using automatic machinery. They are using large mixers, probably twice as large as they were a few years ago. This means more workable and stronger concrete. Nearly all are installing steam curing equipment to give uniform and complete curing of the product. Larger stocks of well cured block are stored in the yards to avoid the necessity of hauling products only a few days old which has resulted in excessive breakage and poor construction.

I believe the producers of crushed stone, especially those interested in using screenings such as I defined a few minutes ago, will find a good market among the concrete products manufacturers in many sections if they will make a study of the requirements of a good concrete products aggregate. Where present aggregates are too harsh I believe that the producers of crushed stone will find their best market among concrete products manufacturers.

Obsolete Versus Modern Equipment

William Feather, in a bit of business philosophy says—"The industrial success of America rests on our willingness to throw out the old and inefficient and install the new and efficient. High wages have compelled us to adopt this policy, because the only chance the American manufacturer has for survival in the world market is by employing machines to do his work. In this situation the business man who would like to play safe finds himself "left on base." Alert competitors, awake to the possibilities for improvements, surge forward, and the mossback dies.

"The most priceless asset of any industry is an open-minded management, keenly alive to the necessity for everlasting self-scrutiny. What can we do to improve our product? To reduce its cost of manufacture? To better our service? To facilitate distribution? Unless an executive is willing to face this daily cross-examination he might as well retire from business. He certainly cannot keep his place if he resists progress. Again, he says, Limited output is the most vicious fallacy that has ever found its way into the minds of working people. Limited output means low wages, high prices, long hours and periods of unemployment. Large output means high wages, short hours, low prices and abundant employment."

One of the major causes for waste in industry has been the interrupted production caused by idle men, idle materials, idle plants and idle equipment.

PAST EXPERIENCE DICTATES PLANT CHANGES FOR LINCOLN SAND AND GRAVEL COMPANY

By E. D. Roberts

FOR twenty-one years the Lincoln Sand & Gravel Company has been dredging sand and gravel from their deposit near Lincoln, Illinois, and 75 acres of the 360 acres comprising the tract have been removed. The company has also developed a clientele that is very valuable to them and have learned, from experience, many things that have been used to advantage to increase the quality of their product, decrease the cost per unit of material, or make more use of the site available for production as well as many other minor things that have been helpful to the company.

The past three years has witnessed a continuous production during the warmer months of a maximum tonnage with the plant operating two full shifts per day. However, the last season was not as active but, with the proposed road work in sight, another three years of maximum demand is considered certain. With this large demand in sight, the company has recently made many changes, with other improvements planned for the near future, based on the experience gained from their previous operation of the deposit.

During the glacial period, many thousands of years ago, a large quantity of sand, gravel and various materials was deposited over the north central states. In places, these deposits are suitable for use as concrete aggregates and in other places they cannot be used successfully. This depends upon the local conditions obtaining at the time of melting or to the natural changes that have taken place since the deposit was laid down. Due to the varying conditions existing at the time of melting, and the natural changes which have taken place since that time, the deposits vary greatly in character;—some are mixtures of mud and gravel, others contain such a large percentage of fine sand that they are rendered unfit for use; others are made up of large boulders, and in other instances the deposit is suitable for use as concrete aggregate, with or without washing to remove the silt and fine sand, or crushing to reduce the size of the larger pieces. Sometimes a combination of both methods is required to produce a material that will pass the rigid specifications imposed on aggregates entering into standard work today.

There are few such suitable deposits in Central Illinois; that of the Lincoln Sand and Gravel Company being the only one of importance within a considerable distance of this plant. It is overlaid with an average of seven feet of earth and after this has been removed there are forty feet of sand and gravel available for use. The country being very flat, with a depression at this point caused by

View of Dredge and Pontoons in Pond

Stripping the Overburden

Salt Creek, water is encountered before the deposit is uncovered. This has called for special treatment and construction to lower the cost of production, the details of which are described in this article.

Owing to the excellent quality of the product and the strategic location of the deposit, the Lincoln Sand & Gravel Company is able to market sand and gravel within a hundred mile radius, which includes such towns as Lincoln, Bloomington, Decatur, Springfield, Champaign, Joliet, Granite City, and Danville, Illinois. Three salesmen cover the territory served by this company, securing orders and maintaining cordial relations with the trade. The many miles of concrete roads being built to connect these cities has also helped to create a great demand for concrete aggregates in this territory.

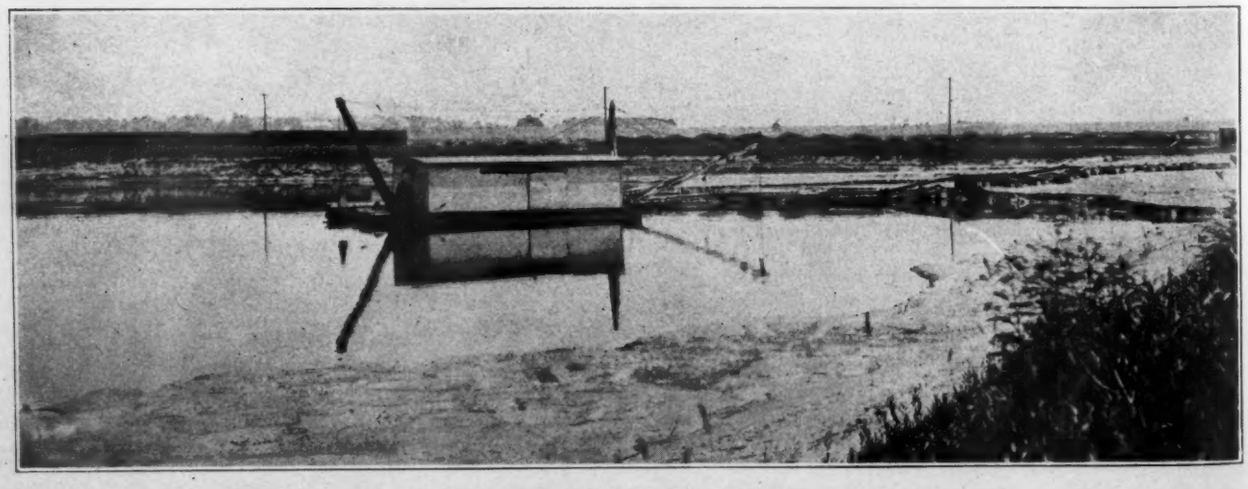
The larger portion of the excavated material is sand, ordinarily a drawback, but not so in this case as four grades of sand are produced; torpedo or concrete sand, medium sand, fine or mason's sand, and engine sand. The last or finest grade is sold to the railroad companies for sanding wet or slippery rails, the consumer drying the sand before using.

We will now return to the details of the process used to prepare the material for market. For a long time the overburden removed from the gravel was placed on adjacent virgin ground. This was the cheapest method for its disposal but a high value was placed on the unworked ground by the assessor, regardless of whether or not it was covered with the stripping. Also, this material required removal, together with the normal overburden. Again, a large portion of the deposit was rendered unavailable for dredging purposes if the stripping was not piled to great heights which, in itself, was not economical. Therefore, a new method was decided on for the disposal of the top soil which was to deposit the stripping in the dredged out portions of the dredge pond. The soil is, therefore, loaded on cars, hauled to the back of the pond and the cars run out on a pontoon from which the soil is dumped into the pond. With this method the pond will in time extend across the tract of land, part of the pond being filled and the land made available for agricultural purposes.

Stripping operations are carried on during the dry months of the year, the top five feet being removed under contract while the remaining two feet is removed by the company. By removing that part of the soil directly over the gravel with their own forces, the company is sure that all the soil is removed from any little pockets that might be encountered which might be overlooked by the contractor.

In cleaning off the gravel, the company uses a McMyler-Interstate crane with a ¾ yard drag bucket, on caterpillar traction, equipped with a Leschen cable. In operation the crane backs away from the work, remaining on the unexcavated soil. Ordinarily, the caterpillars are sufficient to provide a suitable foundation for the crane but, when wet weather is encountered, mats are provided for the caterpillars to travel on.

The excavated soil is discharged from the drag bucket into a movable hopper which places the material into 2 yard side dump industrial railway cars which are hauled, in trains of four cars each, by either a 6 ton Whitcomb or a 6 ton Plymouth



Electric Dredge in Pond

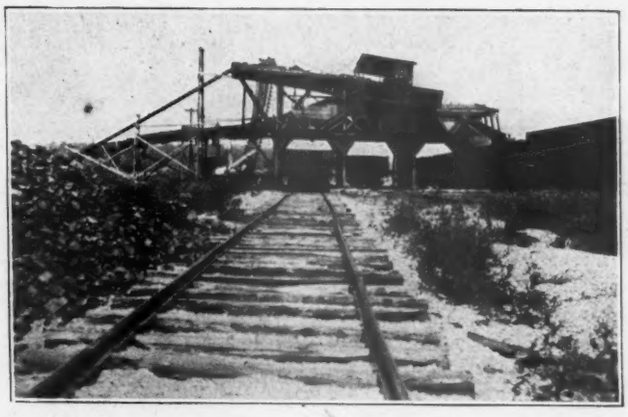
gasoline locomotive. The loaded trains are pushed around to the pontoons and out over the dredge pond where the material is side-dumped into the pond.

To facilitate the removal of the top soil a dyke has been constructed across the old dredge pond dividing it into two separate ponds, one a dredge pond and the other a lake draining into Salt Creek. A 24 inch Morse centrifugal pump, operated by a 75 h. p. Allis Chalmers motor forces the water from the dredge pond into the lake connected to the Salt Creek drainage. This lowering of the water level in the dredge pond allows the top soil to dry, thereby changing the excavation from wet to dry and considerably reducing the cost of its removal. When the stripping operations have been completed for a current season, pumping is discontinued and the water allowed to come back to its normal level, where it remains until the next spring when stripping operations are again resumed.

The dredge is of the usual floating type and removes the sand and gravel from the pond to a screening plant by means of a centrifugal pump and pipe line. This consists of a 250 h. p. variable speed General Electric motor operating an American Manganese centrifugal pump with a 10 inch discharge. The connected pipe line, supported by the pontoons, and the pipe line on the shore together with the difference in elevation of the water and the screening table provide a head of thirty-five feet for the pump. With this equipment 250 tons of finished product is forced through the 10 inch pipe line per day, the plant operating 20 hours per day.

Extremely cold weather is encountered in this locality during the winter months so the plant is not operated during the entire year. However, a reserve supply of classified sand and gravel is built up during the slack seasons of spring and fall to carry over the peak demand of summer and to provide for winter deliveries.

The dredge line discharges on to a fan shaped table of sufficient length and slope to cause the water and material to spread out to about a 40 foot



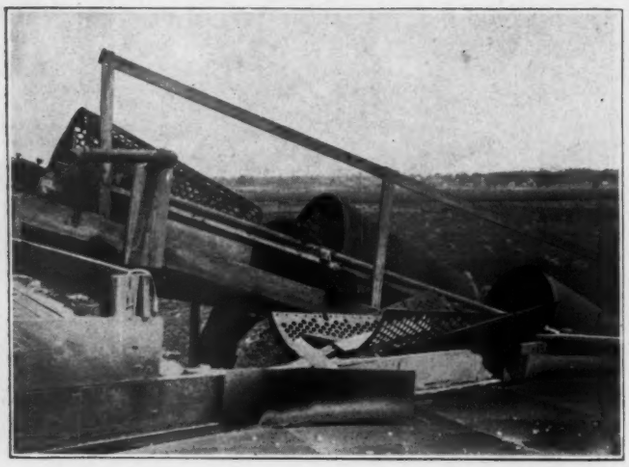
View of Screens and Loading Track

width by the time the material reaches the screens. These are set one over another, the largest size 2½ inch, on top, the next size below and the next smaller size below that. The screens have an inclination of about forty-five degrees and, as the stream flows against the inclination, the particles retained on any one screen cascade down until they encounter a plate on which they slide to the end of the screen.

The oversize goes into a tailings pile, which is very small, the next largest size slides into a bin over the first railroad track, the next size encounters a baffle which turns it back on to a plate, slanting the opposite way, which carries the gravel into a bin over the middle railway track. A change in the screen produces different gravel sizes. The smaller sized materials fall on to a plate which carries the sand and water to sand setting tanks. Here the sand is divided into four grades; torpedo, medium, mason and engine sand, all falling into the proper bin over the third railway track. As only three settling tanks are provided, only three grades of sand can be produced at any one time. The finer materials, not retained as engine sand, go back with the water into the worked over portion of the dredge pond.

To provide for a greater classification of the gravel, the company has, during the past summer, installed a cross belt, a bucket elevator and a set

View along Track from Screens Showing Office (tower between Track) Machine Shop and Round House at Left



New Conical Screens for further Classification of Material

Installing New Conveyor Belt

of conical screens to rescreen the gravel, which are arranged so that all the coarse material will fall from the screens on to this belt. Near the belt an inspector is stationed to remove all the float. The belt then discharges to the bucket elevator which, in turn, discharges to the set of conical screens. There are three screens in the set, thus providing four sizes of gravel; and, if one grade, say pea gravel, is removed by the stationary sloping screens, five grades of gravel will be produced continuously. Chutes are provided to lead the product of each screen into one of the bins. The screens are built over three parallel tracks, with the bins located over the center of the cars. Gates in the bottoms of the bins control the flow of the gravel or sand into the cars.

Previous to two years ago, a locomotive, purchased from the Wabash Railroad, handled the cars from the sidings at Lincoln to the plant and returned them to the proper railroads for shipment. However, at that time a 53 ton Baldwin locomotive and a 42 ton Davenport locomotive were purchased to replace the old Wabash engine. These two locomotives are now handling the switching work.

The field office is located in a building similar to a crossing watchman's tower at a railroad intersection and as the superintendent's office is in the top story of this structure, he can obtain an excellent view of the entire plant area. The outgoing tracks also pass this tower so that it is an easy matter for the field man to keep a check on the outgoing loads. The cars are pulled from the yard to the individual railroad over which they pass to the customer. The lists, or mass bills, made out by the field man, are delivered to the uptown office where railroad bill of ladings are made out as well as the statement which are rendered to the consumer. A system of field telephones connects each unit of the plant with the field office.

Electricity was substituted for steam motive power in the machine shops a little over two years ago, thus completely electrifying the plant with the exception of the engines and locomotive cranes. The machine shop is thoroughly equipped to make any and all repairs required. Several air tools are in use, the compressed air for their operation being provided by a Gardner air compressor.

Two Little Giant locomotive cranes are used to store and reclaim sand and gravel for winter and peak demands. One of these cranes is equipped with car wheels and is operated by steam power, while the other has a caterpillar traction and is operated by a gasoline engine. Eight hundred to 2000 cars of material are stored and reclaimed each season.

The company owns and operates five miles of standard gauge track, all of which has 70 pound rail. Their own engineers design and superintend all new construction, changes or repairs to the plant. The company maintains its own track and switch engines between the plant and the tracks of the Illinois Central Railroad Company, the Chicago & Alton Railroad, and the Illinois Traction Company in Lincoln, which is the shipping point, the latter being about 1½ miles northwest of the plant. The general offices of the company are maintained in the Scully Building in Lincoln.

Mr. V. O. Johnson is president and treasurer of the Lincoln Sand and Gravel Company. Mr. J. C. Brandt is vice-president, while Mr. E. J. Johnson is secretary of the company. These maintain their offices at the main office in Lincoln, while Mr. H. D. Clouse, who is plant superintendent, is located at the plant office.

Largest Bank in the World

The National City Bank of New York City is now the largest bank in the world. It has recently increased its capital from $100,000,000 to $140,000,000. Before this increase, three London banks were larger. The National City Bank is the only American bank with total assets of over $1,000,000,000.

RESEARCHES ON CONCRETE MATERIALS

IMPORTANT researches on cement are under way at the U. S. Bureau of Standards which have in view the development of specifications and methods for testing cements. The comprehensive studies on the constitution of portland cement inaugurated at the Bureau in 1924 in cooperation with the Portland Cement Association have been continued. Studies of volume changes in neat cement and mortar are being continued at the University of Michigan. Studies of the relation between strength of portland cement tested by standard A. S. T. M. methods and the corresponding concrete strength are being made by a number of state highway departments in cooperation with the U. S. Bureau of Public Roads. An extensive investigation on fluid cement-water mixtures, which was begun in 1925 at the Structural Materials Research Laboratory, Lewis Institute, Chicago, was continued and supplementary tests were carried out by 12 laboratories in cooperation with sub-committee VII on Strength of A. S. T. M., committee C-1 on Cement. Further studies on this subject are now being made by 40 laboratories in cooperation with sub-committee VII.

Studies of aggregate include such subjects as effect of grading on strength and yield of concrete, development of abrasion tests for gravel and methods for determining the durability and soundness of aggregates for concrete, effect of loam and shale in coarse aggregate, development of methods for determining quality of fine aggregates, and studies of the suitability of local aggregates for concrete. The majority of investigations under way are concerned with plain concrete. The question of admixtures, both chemical and inert, including coloring materials, is receiving attention. Studies of curing of concrete are under way by the U. S. Bureau of Public Roads and by several state highway departments.

One of the most important researches is the cooperative investigation of a 60-ft. arch dam near Fresno, California, which is being carried out under the auspices of Engineering Foundation; auxiliary tests on the permeability and other properties of concrete are being made at the University of California. Studies of the durability of concrete exposed to alkali, sea water, and freezing and thawing, and studies of volume changes in concrete under various conditions of exposure are receiving much attention. There are a number of investigations under way relating to field tests and methods of controlling the quality of concrete on the job.

Strength tests of concrete building units were carried out by committee P-1 on Standard Building Units and committee P-6 on Concrete Products Plant Operation of the Institute and fire tests on concrete tile walls were made at the Underwriters Laboratories. Researches relating to concrete pavements include such subjects as finishing, relation of subgrade characteristics to behavior of pavement, and the behavior of reinforcing steel in pavements.

Extensive tests are being made on the strength and other properties of concrete, covering such items as compressive, tensile and flexural strength, modulus of elasticity in tension and compression, Poisson's ratio, resistance of concrete to compression in one, two and three directions, etc. These investigations are yielding important new data. Other investigations of plain concrete include studies of flow under load, proportions, retempering, waterproofing, workability, etc. Relatively few investigations are being carried out on reinforced concrete. Among the more important may be mentioned those on web stresses in beams carried out by the U. S. Bureau of Standards and the University of Illinois and the test of a 309-ft. chimney at Duluth, Minnesota, which is under way by Committee S-1 of the Institute.

Some of the Research Results

Constitution of Portland Cement.—(Portland Cement Association Fellowship, U. S. Bureau of Standards, Washington). Continuing the exhaustive investigation of the fundamental chemistry of cement. Taking as a point of departure the investigations by Rankin and Wright on phase equilibria of the lime-alumina-silica system; studies are being made of phase equilibria of other systems made up of constituents in cement. The effect of various impurities normally present in raw materials for cement is being studied by their incorporation singly or in combination in a standard mixture of lime, alumina and silica. Studies of the mechanism of hydration and hydrolysis of individual cement compounds are being made. The optical constants of many materials have been determined and general improvements in petrographic methods of identification have been made. The application of X-ray methods as a means of identification is a recent addition to this work.

Volume Changes in Neat Cement and Mortar.—(University of Michigan, Ann Arbor). A study of the extent of changes and increase or decrease in magnitude with lapses of time. About 200 expansion bars from many different synthetic and natural cements with known histories are available with measurements on all of them. Volume changes with changes in moisture, do not decrease perceptibly for a period of at least 10 years.

Fluid Cement-Water as Criteria of Concrete Strength.—(Research Laboratory, Portland Cement Association, Chicago). A study of the pos-

Editor's Note—Abstracted from report of committee E-3, presented at the American Concrete Institute February 22-24, 1927.

sibilities of fluid cement-water mixtures as criteria of concrete-making properties of portland cement, in order to determine whether such mixtures: (1) more nearly measure the concrete-making value of cement; (2) give more concordant tests by different operators; (3) are more easily and cheaply made than standard mortar tests. Other features of the investigation were: (a) comparison of strength of fluid cement-water mixtures with concrete strength using a wide range of hydraulic cements; (b) development of test for consistency of fluid tests; (d) selection of specimen best suited for strength test; (e) investigation of possibility of early strength test for portland cement at 1 or 3 days; (f) comparison of strengths of fluid cement-water mixtures at different ages with 1:3 standard sand briquets and cylinders.

Effect of Grading of Aggregates on Strength of Concrete.—(Iowa State Highway Commission, Ames). Wide variations in grading of coarse aggregates due to differences in deposits and due to segregation by improper piling methods in handling materials, even from a single source, have caused much speculation as to the probable effect of variations in grading upon strength of concrete. An investigation for this factor has thus far indicated that variations in grading, except for improbable extremes, have a negligible effect upon strength of concrete made with proportions having even a slight excess of mortar in the mix. This has permitted a wider range of use in different proportions of materials from certain plants which had been limited largely to use in only one proportion.

Sandstone for Concrete Aggregate.—(University of Kentucky, Lexington). Study to find ways to use sandstone satisfactorily in concrete. Tests show that sandstone having less than 6 per cent wear can be successfully used in concrete pavement, and that this limit may be extended up to 10 or 12 per cent. Progress has been sufficient to cause highway departments to construct 18 miles of concrete pavement using sandstone having 6 per cent wear for both coarse and fine aggregate.

Dirty Stone as Coarse Aggregate.—(University of Kentucky, Lexington). Effect of dirty stone on 28-day, 1, 2 and 3-yr. compressive strengths of concrete cylinders exposed to weather after 28 days. Stone showed 4.5 per cent loss by washing, about one-half of which was clay and silt, and one-half limestone dust. Judging from 28-day and 1-yr. tests, dirt appeared to have no harmful effect.

Study of Methods for Determining Quality of Fine Aggregates.—(U. S. Bureau of Public Roads, Washington). Investigation of proposed test for quality of concrete sands involves application of water-cement ratio principle which may be substituted for present unsatisfactory strength-ratio test.

24-Hr. Strength Test for Sand.—(Kansas State Agricultural College, Manhattan, Kan.). Accelerated test for predicting strength of sand for concrete. Lumnite cement used for 24-hr. tests for comparison with portland cement strength-ratios at 7 and 28 days. Tension and compression tests compared with parallel tests on Ottawa sand. Seems probable that 24-hr. test will be satisfactory, but it remains to be investigated whether it will detect injurious organic matter.

Effect of Shale on Strength of Concrete.—(Iowa State Highway Commission, Ames). Shale in very small amounts affected strength of concrete. Most serious effect arises from pitting of finished surface by spalling of concrete due to expansion of shale pebbles after concrete has set. To prevent an unsightly surface, as well as to avoid impairment of strength, quantity of shale must be kept small. Presence of rotten stone in aggregate affects strength less than the shale, but this material disintegrates when exposed to weather and crumbles under action of traffic. More than about 3 per cent by weight in coarse aggregate is likely to result in a speckled surface due to holes left by rotten stone after about 1 or 2 years.

Abrasive Resistance of Concrete.—(Kansas State Agricultural College, Manhattan, Kan.). As affected by various items, particularly the abrasive value of coarse aggregate. Study has been made of various brands of cement, cement hardeners, proportions and coarse aggregates having loss of from 2 to 20 per cent. Nine-in. concrete spheres tested in a standard brick rattler. Three spheres constitute a charge, 900 revolutions producing sufficient loss for comparative purposes. Tests furnished dependable means of measuring abrasive resistance of various concretes. Abrasive loss of concrete not seriously affected by abrasive value of coarse aggregate for aggregate losses of 8 per cent or less.

Calcium Chloride as an Admixture.—(Iowa State Highway Commission, Ames). Studies by several investigators indicate that small amounts of calcium chloride when used as an admixture in concrete have effect of accelerating hardening so that relatively high strength is secured in a few days. If calcium chloride can be used without disadvantageous results, important applications are possible. If it is proper to use this method as a substitute for damp earth covering in curing of concrete road slabs, there are many obvious advantages to both contractor and engineer. Several miles of pavement, with calcium chloride as an admixture, are now being constructed in Iowa. The research organization has a special crew making tests of the quality of this concrete in comparison with concrete not so treated and careful observation is made of all factors which appear to have a bearing on this problem. The laboratory is making parallel tests.

Control of Water Content of Concrete Mixtures.—(Iowa State Highway Commission, Ames). It is a generally accepted fact that for uniformity, a definite ratio of water to cement should be maintained. On concrete pavement construction, due to variable moisture content of aggregates, speed of operation, large quantities of materials handled per batch, variation in water measuring devices, and a measurement of materials miles away from the mixer, keeping a constant water content presents many difficulties. Studies made during the past two seasons indicate that consistently accurate water measuring devices are a possibility, and that much improvement can be made in the control of the other factors.

Investigation of Accuracy of Volumetric Field Method of Proportioning by Void Bulkmeter Apparatus.—(Illinois Division of Highways, Springfield). Study to check volume, gradation, voids, unit weight and compaction of aggregates during handling and the bulking of fine aggregates. Batch of coarse aggregate placed in void bulkmeter, initial reading of volume taken and batch then hauled 6 miles and amount of settlement determined at end of each mile. Voids determined by water displacement method. Entire batch then sieved. Batch of fine aggregate hauled same as coarse aggregate then inundated at end of 6 miles for relation of settlement due to haul and that obtained by inundation.

Average variation of actual field volumes of coarse aggregate at 40 proportioning plants was within 2 per cent of theoretical volume; average variation of actual field volumes of fine aggregate showed a deficiency in the sand of 8 per cent based on the inundated volume and not on the resulting volume due to haul; use of compacted volumes of materials to conform to 1: 2: 3½ volumetric proportions gives an increase in transverse strength over strength obtained under present field methods; workability of concrete is more affected by a deficiency of sand in angular than in rounded material.

Making Concrete Entirely by Water-Cement Ratio.—(Barney-Ahlers Construction Corp., New York City). Study to obtain concrete of maximum uniformity of strength and as near required strength as possible. Proportioning water exactly to amount of cement, mechanically; deducting mechanically from water tank estimated amount of water contained in aggregate; controlling consistency of concrete by amount of aggregate used; establishing "Job Constant of Strength" which fixes water-cement ratio for any type (strength) of concrete.

The Ahlers Concrete Strength Regulator, which balances each batch of water against cement automatically and insures constant water-cement ratio between batch and batch, making possible exact water-ratio control without recourse to calculations, was used. Water-ratio control possible for field use; results from concrete made under this method of measuring the water and cement are remarkably uniform; concrete can be placed more easily and economically.

Concrete in Tension.—(University of Maryland, College Park). Comparison of strength in tension to strength in compression. Special apparatus used consisting of molds for casting tension specimens and brass end clips for holding specimens in testing machines. For mortars and concretes less than 90 days old, ratio of tensile to compressive strength is practically the same for mortar and concrete, but varies with age from 15 to 18 per cent. For all mortars and concretes over 90 days old, ratio was about 8 per cent and constant whatever the age.

There Is a Limit to Salvage Economy

Much has been said about waste elimination and the necessity for systematized salvage and reclamation. That advice was greatly needed and has doubtless done much to reduce needless expense. It should be remembered, however, there is a point beyond which salvage or reclamation becomes unprofitable. An ordinary pipe wrench, globe valve or grease cup, for instance, may be only slightly out of repair and it seems a shame to discard the piece as useless. But calculate the cost of a workman's time in putting the piece back into shape against the cost of a new piece, and the results will frequently indicate the purchase of new equipment as the more economical way out. Even the best of workmen can easily spend two or three dollars worth of time in taking a valve apart, repairing and reassembling it, whereas a new valve would probably cost no more, if as much.

Nails, bolts, bars, chisels, wood screws, nuts, and other simple forms of equipment nearly always justify salvage effort or at least the consideration of reclamation costs. Doubtless the annual waste in such small parts, due to careless handling, mislaying, unwise issuance, corrosion, etc., runs into the millions of dollars—much of which might be saved through increased attention and systematic organization. As for old and decrepit machinery, however, the cost of patching and repair frequently exceeds the cost of new equipment—with no possibility for increased efficiency or lasting investment. It is a duty of management to instill into every employe the realization that waste, in whatever form, militates as much against themselves as the company, and that no individual, company or nation is rich enough to tolerate it.

American Road Builders Move Office

The American Road Builders' Association have removed their offices from 37 West 39th St., New York, to the Earle Building, Washington, D. C. The office of the National Crushed Stone Association is in the same building.

CONCRETE A FIELD FOR NEEDED RESEARCH

By Herbert J. Gilkey
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OVER a period of years several series of tests have been conducted in the concrete laboratory of the University of Colorado, with a view to comparing the strengths of mortars and concretes which were identical except for the absence or presence of coarse aggregate. Without exception the mortars gave higher strengths than the concretes. Usually these were from 10 to 20 per cent greater, but the increases were sometimes as much as 50 per cent. In general the difference becomes less as the sizes of the particles and the proportions of the coarse aggregate are diminished. The same facts have been noted by others and there are some published statements to this effect.

The usual point of view held by designers of concrete mixtures has been that the strength of concrete is essentially the strength of its mortar, the coarse aggregate being but an inert diluting material introduced mainly to save mortar. Some investigators have made statements to this effect, others imply it. The reasonableness of this point of view is evident to most persons. If tests do not verify it, the reason for the lack of agreement between the strength of the concrete and that of its mortar would appear to be traceable to one or more of the following factors:

1. The lack of homogeneity caused by the introduction of the coarse material.
2. Failure in bond between the mortar and the particles of coarse aggregate.
3. Weakness in the aggregate itself.
4. Chemical effects of the aggregate upon the mortar strength.

The last two reasons are, in general, absent. The usual definition of coarse aggregate, viz.: a material chemically inert, structurally sound, and at least as strong as the mortar matrix, excludes these.

Most investigations of concrete have been conducted with graded aggregate, generally one of the local products. Variations in size (or grading), shape, surfaces of aggregates, etc., may all exist as simultaneous variables. The effect of any one factor cannot be isolated, in such a case.

Thought along these general lines has suggested to the writer the possibility and desirability of a fundamental and comprehensive investigation of coarse aggregates, with a view to running down each one of these factors in turn. The investigation planned is far beyond what it would be possible to conduct in any but a large laboratory with considerable resource. Regardless of whether or not such an investigation were actually launched, the writer is convinced that much benefit would accrue from getting these ideas before the leading present-day thinkers and investigators in concrete.

Just how the problem of isolating and attacking but one variable at a time can best be approached and can only be shown by a rather detailed outline of a hypothetical series of tests. The individual effects of shape of particle, size, surface, strength, and quantity are each to be run down in turn. Then would come some of the simpler combinations of factors, or elements, leading to general laws or conclusions that would be applicable to practical conditions.

The subject will be treated under three main headings, viz.:

1. Presentation of the problem.
2. Presentation of experimental evidence of a reconnaissance nature indicating probable trends and possible magnitudes.
3. Outline of the proposed investigation and discussion in some detail of possible methods of attacking the problem. This includes a consideration of:

(a) The selection of pertinent variables.

(b) Some of the difficulties that would be encountered and suggestions of ways to overcome or avoid them.

(c) General remarks, speculative or otherwise, that might have either a direct or indirect bearing upon the subject.

Presentation of Problems

(A) Some eminent authorities maintain that for workable mixtures, the strength of the concrete is the strength of its mortar.

(B) Some, while granting that the above may not be strictly true, contend that the difference is so slight that it is not of practical importance.

(C) Others assert that the strength of the concrete is by no means the strength of its mortar and that the difference is of sufficient magnitude to make it far from negligible.

Those of the (A) pursuasion deny the existence of a problem. Class (B) grant its existence but brand it not worth solving. It is something of academic interest from the standpoint of the theorist or pure scientist, perhaps, but one of those unprofitable speculative items of which the practical man should steer clear. To those of class (C) there seems to be a real problem of sufficient practical, as well as scientific, interest to challenge alike the curiosity and best efforts of the practical man and his less practical, but intelligently curious, neighbor, the scientist or the pedagogue who is

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perhaps more interested in reasons why than he is in dollars saved.

In class (A) we find the two foremost present-day investigators in the field of concrete, Talbot and Abrams.

The water-cement ratio strength criterion of Abrams excludes both the coarse and the fine aggregate from having any bearing upon strength of concrete except in so far as they influence the amount of water necessary for workability. It is presupposed, of course, that the aggregates and that proportions of cement, water and aggregates are within the recognized workable range. In other words, Abrams, like Talbot, very properly excludes freak aggregates and freak proportions. Abrams' fineness modulus has nothing whatever to do with the strength or the water-cement ratio strength criterion. It is simply a constant obtainable from the sieve analysis, for the purpose of pre-determining the amount of water necessary to produce a concrete of satisfactory workability from given aggregates. Moreover, it is supposed to supply evidence as to whether or not the aggregates are so graded as to produce concrete not too harsh for proper workabilty or so fine as to require too much water for proper economy of cement. If the fineness modulus were not known in advance, the information supplied by it could be obtained by trial mixtures. In so far as either fineness modulus or surface modulus (which is simply another constant based on the sieve analysis, exactly analogous to fineness modulus as regards scope and function) are imperfect as criterions, the actual mixture will need experimental modification.

Thus, although the fineness modulus is an incidental and more or less useful adjunct of the water-cement ratio theory, the water-cement ratio is the sole strength criterion proposed by Abrams, and within the range of proper workability, strength will vary with this ratio and with it alone. Size, quantity and grading of aggregates may be shifted at will, within the workability range, without influencing the strength of the concrete. This is the doctrine of Abrams and leaves no loophole for any difference in strength between workable mortars and concretes of equal water cement ratios. Nor does it leave any loophole for differences in strength due to grading as long as the same water cement ratio is maintained and workability is not sacrificed.

With Abrams' theory the difference in strength by virtue of grading arises from the fact that the coarser the grading, without over-shooting into the realms of harsh unworkable mixtures, the greater the apparent wetness of mix a given water ratio will provide and it is possible to get a workable mixture with a lower water ratio than can be attained with smaller sized aggregates (lower fineness or higher surface moduli). At constant water cement ratio these experiments, and those of others seem to indicate very definitely that the larger the grading of the coarse aggregate, the weaker the concrete. If the water ratio be also variable then we have a concrete stronger because of less water, as size of aggregate increases, and weaker by virtue of larger aggregate (possibly because of less surface factors simultaneously present and there may be some doubt as to which way the balance might be thrown in a particular case). This point is, however, one to be considered later. For the present the purpose is to show clearly that Professor Abrams' position is inevitably that of Class (A). "Mortars and concretes of equal water cement ratios have equal strengths and the present problem does not therefore exist."

As to the evidence that Talbot is of Class (A) mind, it will possibly be best to quote his own words as used on pages 80 and 81 of Bulletin 137:

"The points representing the mortars were somewhat more scattered than the points in diagrams representing the tests of concrete, and they generally fell below the curve of the concrete tests. Two other sets of mortar specimens, 6 x 12-in. cylinders, made in connection with later series of tests of concretes, gave compressive strengths at or above the curve for the relation between voids-cement ratio and strength of concrete. Several series of tests made elsewhere indicate that the voids-cement-strength relation holds for both mortars and concretes. Differences between the strength of mortars and concretes as indicated by the voids-water content, in manipulation in making the specimen (such as those affecting compactness), and in conditions attendant on differences of size of specimen.

"Other things being the same, it may be asserted that below a reasonable limit for the amount of the coarse aggregate, the strength of the concrete is identical with the strength of the mortar composing it. 'Other things' refer to relative water content, manipulation in placing, and compactness of mortar and concrete, absorptive properties of coarse aggregate, manner of curing and testing, etc. In making a comparison of the relative strengths of mortars and concretes, special care should be taken to secure identical conditions. It is further assumed that the strength of the particles of coarse aggregate is at least as great as the strength of the mortar and that the adhesion of cement to the coarse aggregate is as great as to the fine aggregate. Under this view, the coarse aggregate becomes only a filler, concentrating the mortar and making it richer for a given amount of cement in a fixed volume of concrete. This conception of the function of the mortar simplifies the process of designing the mixture, for the voids-cement ratio of the concrete in good workable mixtures will be essentially the same as that of the contained mortar. This conception also leads to a better comprehension of the source of the strength and the effect of variations in mixtures."

That more recent developments at Illinois may

be modifying the very definite position taken on pp. 80 and 81 of Bulletin 137, is perhaps indicated by the utterance of Professor Richart, *Proceedings*, American Concrete Institute, 1925, pp. 177-178 quoted below:

"Mr. Hutchinson's observations regarding the effect of the size of the coarse aggregate are substantiated to some degree by some tests conducted recently at the University of Illinois. A series of tests of the compressive strength of concrete mixtures taken from the table of proportions given in the report of the Joint Committee on Specifications for Concrete and Reinforced Concrete includes concretes made with three gradations of sand and three of coarse aggregate, three consistencies and three designed strengths. The coarse aggregates used were gravels of gradations designated as No. 4 to ¾ in., No. 4 to 2 in., and ¾ to 2 in. The principal feature of the tests was that the concrete made with the first coarse aggregate gave unexpectedly high strengths, and that containing the last, the ¾ to 2 in. material, gave relatively low strengths. That is, this rather uniformly graded coarse aggregate, in which the particles were of large size and which had a high fineness modulus, gave low strengths, while the better graded aggregates, the one having the smaller maximum size, gave the best results. These unexpected variations in strength are not only variations from the designed strength, but also variations to a marked degree from the curves expressing the relation between the strength and water-cement ratio and voids-cement ratio.

"It would seem that the explanation might lie in the extent and condition of the surface of the coarse aggregates. While all of the aggregates were from the same source, the surface moduli, in the order mentioned above were 1.27, 0.92, and 0.35, so that the coarse aggregate giving the least strength had only about one-fourth as much surface area as the one giving the highest strength. The strength of the concrete may also be affected by the extent of the bearing contact and interlocking between particles of coarse aggregate, in a way similar to that observed in the action of railway track ballast."

In this discussion, concretes and mortars are not being compared, but to concede that identical concretes except for differences of gradations, of coarse aggregates, can have different strengths is as much of a reversal of the previous stand as to admit that mortars and concretes of identical voids-cement ratios have not identical strengths. All of the discussions on pp. 177 to 179 (Proceedings A. C. 1, 1925) are very pertinent to this subject as are also many portions of the paper just preceding, by Mr. G. W. Hutchinson. Several of the opposing points of view are well set forth.

Mr. Hutchinson here, and elsewhere has produced rather convincing proof that the compressive strength of the concrete, and especially its resistance to impact, decrease appreciably with increase in size of coarse aggregate particles. This is directly contrary to Abrams' contention but is very well supported by the evidence of these tests as regards compressive strength. This series does not include any impact tests.

Definite support of the Class (C) contention is given by George M. Williams. In Hool and Kinne, "Reinforced Concrete and Masonry Structures," foot of p. 17, he states:

"An assumption sometimes made is that the strength of the concrete will be that of the mortar used. Such an assumption is erroneous since the concrete strength may be as little as 50 per cent of that of the mortar."

Again at the foot of p. 28, same text, he states:

"Owing to the limited capacities of available testing machines, it has been customary on some work, where aggregates up to 4 or 6 in. maximum size have been used, to mold small specimens with the fine material screened from the concrete. Such tests will no doubt indicate comparative qualities but may give little idea of the actual strength values obtained in the work as these mortars may test from 50 to 100 per cent higher than the original concrete is placed."

Conclusions

1. Very eminent authorities differ as to whether or not the coarse aggregate bears any practical relationship to the strength of the concrete.

2. These tests in common with others here and elsewhere seem to indicate beyond reasonable doubt that the coarse aggregate is closely linked to strength. The concrete is not as strong as its mortar.

3. There therefore seems to be defined a real need for a thorough and fundamental investigation of the different aspects of coarse aggregate in concrete. This could only be undertaken by some large well-equipped laboratory or several such. Even then the problem offers what seems to be insurmountable difficulties in eliminating simultaneous variables unless synthetic precast coarse aggregates of mortar be used.

4. It is felt that it would be a splendid thing for the cause of concrete, if such an investigation, as is here outlined, could be adequately and properly launched. In the absence of such a launching it is still felt that to get these problems before the eyes and minds of the thinking concrete public cannot help but be a splendid thing for the cause of concrete.

Texas May Change Highway Plan

A bill which provides for the abolishment of the State Highway Commission and the placing of Highway Department under the executive head has been introduced in the Senate of Texas.

BEET PULP FOUND TO BE DESTRUCTIVE ON PORTLAND CEMENT CONCRETE

By O. V. Adams

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IN THE beet sugar manufacturing process, a substance known as pulp remains after the sugar has been exhausted from the beets. Approximately one ton of pulp is produced for each ton of beets treated. The pulp is stored in silos and later used for stock feeding. For hauling pulp to the feeding pens, wagons equipped with ordinary boxes were formerly used. Since Portland cement concrete has come into widespread use as a paving material, regulations have been made by some city and county governments requiring the use of water-tight wagons which must be inspected and approved before being used. They must not be loaded so that any pulp will run over the sides. Other regulations prohibit the use of pavements by vehicles hauling pulp.

These regulations have been passed on account of the prevailing belief that beet pulp has a detrimental effect on Portland cement concrete. The behavior of concrete floors in pulp silos at some beet sugar factories and the condition of a concrete pavement near Loveland, Colorado, which is used by beet-pulp trade, have contributed to this belief.

The facts concerning two of these instances are as follows: The Windsor pulp-silo floor was 6 inches thick when constructed in 1920. A 1 to 6 mix of Portland cement and pit run gravel was used. In 1924 it was found that the mortar on the surface had been eaten away, leaving the coarse aggregate exposed. The concrete, to a depth of 0.50 to 1 inch, had either been entirely destroyed or its strength so badly impaired that it could be cut easily with a pocket knife.

The concrete surface on the highway near a sugar factory at Loveland, Colorado, was constructed in 1915. The specifications, under which the work was done, were furnished by the Portland Cement Association. The materials used were all tested and the aggregates were the best that could be obtained locally. The mix used was one part of Portland cement to two parts of sand which passed a 0.25-in. screen to three parts gravel which passed a 1½-in. screen. The concrete surface is 18 ft. wide and was originally 8¼ in. thick at the center and 6 in. thick at the sides. The workmanship was satisfactory and the officials of the sugar company state that the pavement, when completed, appeared to be first class in every particular. During the years immediately following the construction of the pavement, the beet pulp was hauled entirely in steel-tired vehicles. During the past few years the amount hauled in trucks equipped with rubber tires has been increasing.

The average weight of a two-horse team and empty wagon is approximately two and one-fourth tons. When loaded, the average weight is approximately six and one-fourth tons. Therefore, about eight and one-half tons of traffic are produced for each four tons of beet pulp hauled in wagons. By actual count on three days in December, 1924, 65 per cent of the total tonnage consisted of steel-tired vehicles. It seems, therefore, safe to say, that during the life of the pavement, 82½ per cent of the pulp has been hauled in steel-tired, horse-drawn vehicles. For a mean annual pulp tonnage of 55,000, 45,000 tons have therefore been hauled in steel-tired horse-drawn vehicles. This has produced 117,000 tons of traffic per annum, 96,000 tons of which was steel-tired, horse-drawn.

The pulp silo is located about one-third of a mile from the north end of the pavement. The three-day traffic count in December, 1924, showed 38 per cent of the pulp traffic went over the north end of the pavement and 62 per cent over the south end. This amounts to 44,500 tons and 72,500 tons over the north and south ends, respectively. The traffic due to beet hauling is approximately 45,000 tons per annum. By using the same distribution percentages as for beet pulp, 14,000 tons and 23,000 tons of steel-tired, horse-drawn traffic passed over the north and south ends of the pavement respectively, and 8,000 tons were hauled in rubber-tired vehicles.

A three-day traffic count was made in August, 1924. The average daily traffic as shown by the August and December counts was 250 vehicles per day, exclusive of beet and beet-pulp traffic. Twelve and one-half per cent of this was horse-drawn traffic. If the average weight is taken as one and one-half tons per vehicle, the total traffic per annum is found to have been 137,000 tons, 17,000 tons of which was horse-drawn. In 1916 the pavement was so badly rutted as to need repair. A covering of Tarvia A and Tarvia B was applied. This did not prove satisfactory as it soon rutted to the original pavement. Nothing more was done until 1920 when the ruts were filled with gravel and hot asphalt applied by the penetration method. This treatment proved fairly satisfactory. The ruts were filled somewhat more than level full, which encouraged the traffic on the concrete outside of the old ruts. New ruts were soon formed in the

*Abstracted from report number 306 issued by the engineering division of the Colorado Experiment Station.

concrete. At the present time (1924) the south three-fourths of the pavement is badly rutted.

Laboratory Tests

In order to obtain additional information on the effect of beet pulp on Portland cement mortar and concrete, laboratory tests covering a period of nearly three years were performed. Three series of specimens, which have been designated "A," "B" and "C" were prepared. In each series, tension and abrasion tests were made on cement mortar and compression tests on cement concrete. The mortar used in all tension and abrasion specimens contained, by weight, one part cement to two parts fine aggregate, with sufficient water to produce a mortar of standard consistency.

In series "A," the aggregate was sand and gravel of granite origin obtained from stock piles of The Lock Joint Pipe Company, which was at that time making concrete pipe for the Fort Collins storm sewer. The gravel was screened and recombined. A 1:2:3 mix by weight was used in the compression specimens. In series "B," the sand and gravel came from the same source as series "A." The mix used in compression specimens was 1:1.46:3.54 by weight. In series "C," crushed red sandstone was used as coarse aggregate and "crusher fines" as fine aggregate. These were obtained from the quarry at Lyons, Colorado, owned by Mr. J. C. Brodie.

The mix used was 1:1.46:3.21 by weight. The mix in both series "B" and "C" was designed so as to obtain as dense concrete as possible. Physical tests of the sandstone gave the following results:

Specific gravity	2.46
Absorption	1.6 per cent
Per cent of wear	3.57
Hardness coefficient	17.2
Toughness coefficient	8.0

Each series consisted of 84 tension, 288 abrasion and 36 compression specimens. The tensile specimens were briquettes of the standard form. One-and-seven-sixteenth-inch cubes were used for abrasion tests, and four-by-six-inch cylinders for compression tests.

The laboratory tests bring out the following points:

The pulp-storage tension specimens showed no appreciable reduction in strength after having been stored in pulp 153 days, but did show a marked reduction for 383 and 709 days' storage. The average strength of tensile specimens for 709 days' pulp storage was only 65 per cent of that of specimens stored in moist sand. There was a slight reduction in compressive strength of pulp-storage as compared with sand-storage cylinders for 153 days' storage. For 383 days' pulp storage there was an increase in compressive strength over that for 153 days' pulp storage for all three series. Only in series "A" was there a marked reduction in compressive-strength ratio for 383 days' storage, as compared with 153 days' storage.

There was a marked reduction in both the actual compressive strength and the compressive-strength ratio of all series for 709 days as compared with 383 days' pulp storage. There was an increase in compressive strength up to 709 days' moist-sand storage for series "A" and "C" and up to 383 days moist-sand storage for series "B." The strengths of cylinders stored in moist sand for 709 days for series "A," "B" and "C" were 200, 169 and 169 per cent, respectively, of the 28-day strength. The abrasion-loss ratio was always greater than one and increased progressively as the pulp-storage time was increased. The pulp-storage cubes were lighter at the end of all three storage periods than the sand-storage specimens.

The loss in weight of pulp-storage cubes amounted to 11.3, 13.1 and 14.7 per cent for series "A," "B" and "C," respectively for 709 days' storage.

Conclusions

Beet pulp has a destructive effect upon both the mortar and concrete specimens used in laboratory tests. This destructive action is not great up to 150 days of pulp storage but increases progressively for longer periods. Results of tests and field observations show that while there is no doubt that concrete and mortar are affected by beet pulp, it cannot be said that the rutting and wear on the concrete pavement at Loveland, Colorado, has been due to beet-pulp action alone.

Chemical Society to Hear About Lime

Lime producers will be interested in hearing Richard K. Meade, one of the pioneers in kiln design, and recognized as an authority on the subject, discuss Kiln Design at the Lime Symposium, three half-day sessions at the Spring Meeting of the American Chemical Society, Richmond, Va., April 11-16. Although the lime industry was solidly established in this country in 1733, the early development was slow, but during the last 15 or 20 years great strides have been made. Mr. Meade will discuss the relative advantages of shaft and rotary kilns, as well as some of the interesting problems encountered in recent developments.

The papers on Lime Kiln Fuel Efficiencies by Azbe; Lime Hydration, by Adams; and Lime Research, by Haslam, will also be of exceptional interest to both lime producers and chemists who make use of lime in their processes and industries. Prof. J. R. Withrow, head of the Chemical Engineering Department, Ohio State University, is in charge of the preparation of the Symposium, and will preside during the sessions.

SOURCES OF DUST IN COAL MINES

THE most prolific source of coal dust in coal mines is dry undercutting of the coal, the Bureau of Mines, Department of Commerce, has ascertained in the course of an investigation covering 15 representative coal mines in six coal-mining states. It was found that dust in the surrounding air resulting from dry undercutting operations averaged 9,810,000,000 particles per cubic meter of air. Where water was applied to the cutter-bar, dust in the air caused by undercutting the coal averaged but one-seventh of the amount caused by dry undercutting. The information brings out clearly the importance of using water in undercutting operations as a means of reducing the coal-dust hazard, a big factor in mine explosions.

The highest dust count per unit of air volume was found to be raised by jackhammer drilling in the mine roof. The average dust count from this source reached the amazing figure of 132,020,000,000 particles per cubic meter of air. The most common sources of coal dust, aside from undercutting with mining machines, were the loading of coal at face of workings and the transportation of coal. The principal factors that enter into the prevention of coal dust as determined by the Bureau of Mines in this study are the application of water to the cutter-bar of mining machines, watering coal before and after loading, water sprays at main partings or key points, and spraying ingoing empty cars.

In addition to the use of water on the cutter-bar, water was applied in a number of instances by miners with a hose to the coal after it had been broken down. They also washed the face of workings and drenched the loaded cars before these left the working places. Less dust was found in the air of haulageways in those mines in which water was used plentifully at the face than in those using dry methods. It is evident that in such a case less dust is present in the air of the working places to be carried by ventilating currents, also, less dust can be swept from cars which have previously been drenched with water. Furthermore, the dripping of water from such cars will keep the road dust damp, thus making it difficult for moving air currents to sweep it into the atmosphere.

The use of water sprays at main partings or other key points underground to dampen the top of loaded or empty cars, which have lost some of their moisture, is another means of reducing the atmospheric dustiness. These moisture losses may occur during delays and by exposure to moving currents occasioned by long hauls. The spraying of ingoing empty cars provides another means by which to reduce the dust in the air. A certain amount of coal dust remains in the cars after they have been dumped. The spraying of these cars before entering the mine to a large extent prevents this dust drying, if damp, or falling from or through the car, if dry.

Mechanical drilling has been shown to raise much more dust than any of the other mining operations. In some instances, this is not coal dust, but rather the sandstone or shale material that overlies the coal. However, there is a definite hazard connected therewith which would be greatly reduced by the substitution of wet for dry drilling methods. It has been repeatedly shown by investigations in metal mines that wet drills raise but a fraction of the amount of dust produced by corresponding dry tools. Coal as well as metal mines should avail themselves of this improved practice.

Coal dust spilled along haulageways can be caught and raised into the air by air currents caused either by ventilation or by the movement of trips. A great deal of such spillage can be prevented by the use of tight-end cars in place of the loose end-gate type so much in vogue. Lump coal which falls from trips to the tracks is soon broken and ground into dust by the passage of trips. This can then be stirred up by all air currents which pass. A minimum topping of all cars would reduce this spillage to a negligible quantity. Many mine cars are allowed to remain in very poor repair. Often wheels have worn unevenly or are broken so that they are not true. Rapid movement of such a car would tend to shake coal off the top and through the cracks.

Much dust on haulage roads is due to uneven, poorly laid track. For this reason all track should be carefully laid and all installations to be used over a long period should be well graded, ballasted with rock, and well maintained. The ballast should be gravel, surface soil, slag, or cinders, but never coal. Maintenance should include the frequent cleaning of track by company men definitely assigned to this job.

Although the liberal use of water greatly reduces the amount of dust formed, it should be supplemented by sufficient quantities of circulating air to remove any dust that may be raised. In nearly all of the samples taken at the face there was little or no movement of air and as a result some extremely fine dust remained suspended over a considerable period. This condition could have been obviated by supplying moving air at the face of workings. Dust below 10 microns in size remains suspended for a longer period than dust above 10 microns. This smaller size of dust is probably more harmful than the larger particles because of the large amount of surface exposed, hence it should be removed by ventilation as quickly as possible.

Because the presence of coal dust in mine air presents an explosion hazard, the question of decreasing its amount is extremely important. The

Bureau of Mines has recommended that all coal mines be rock-dusted as an explosion preventive. This investigation forcibly brings out the fact that the liberal use of water at the face of workings greatly reduces the amount of coal dust raised. It is not the intention of the Bureau of Mines to advocate the use of water in place of rock-dusting back from the face of workings, but rather to supplement it. Furthermore, it would be an economical measure to use water at such points because, if less coal dust was raised into the air and carried by ventilating currents to be deposited on the ribs, roof, and floor over the rock dust, the life of an application of rock dust would be greatly lengthened.

Louisville Cement Awarded Certificate for Exceptional Safety Record

Instances of the operation of mines over long periods of time with exceptional safety have been commemorated by the Holmes Safety Award Committee of the Joseph A. Holmes Safety Association in the awarding of certificates to two coal-mining operations whose records show the production of great tonnages of coal without a fatal accident and to a metal mine and a stone quarry where no employe lost even as much as a day's time because of injuries.

A certificate was awarded to number 6 mine of the United States Coal and Coke Company at Gary, W. Va. This mine was operated for a period of almost ten years, from February 24, 1917, to December 31, 1926, without a fatal accident. During this period, 606,072 man-shifts, or approximately 5,455,000 man-hours, were worked by the underground employes of the mine, and 214,667 man-shifts, or approximately 1,932,000 man-hours, were worked by the surface employes of the mine. The production of coal during this time amounted to 6,030,862 short tons.

The Benjamin, Francis and Berry coal mines, of the Ford Collieries Company, at Curtisville, Pa., were awarded a certificate in recognition of their operation for a period of more than six years, from August 14, 1920, to December 31, 1926, without a fatal accident underground, and from October 10, 1922, to December 31, 1926, without a fatal accident above ground. Since the last fatality underground, the underground employes of these three coal mines have worked 922,628 man-shifts, or approximately 7,381,000 man-hours, and have produced 5,755,669 short tons of coal. Since the last surface fatality, the production of coal has been 3,705,669 short tons, and the employes, underground and surface, have worked 628,481 man-shifts, or approximately 5,008,000 man-hours.

In the metal-mining field, a certificate was awarded to the Muncie zinc and lead mine operated by the Federal Mining and Smelting Company at Baxter Springs, Kansas. This mine was operated from July 23, 1925, to December 31, 1926, not only without a single fatal accident, but without a "lost-time" accident underground. A "lost-time" accident is one in which the injured worker loses at least a full day's work as the result of the accident. A total of 39,489 underground man-shifts, equivalent to 315,912 man-hours, was worked during this time without a "lost-time" accident.

In the quarrying field, a certificate was awarded to the Speed open limestone-rock quarry operated by the Louisville Cement Company at Speed, Indiana. No fatal accident and no "lost-time" accidents occurred at this quarry during a period of more than two years from June 1, 1924, to December 31, 1926. A total of 545,497 man-hours, or 60,611 man-days, was worked at this quarry during this period.

The Joseph A. Holmes Safety Association is an organization named in honor of the first director of the United States Bureau of Mines, now deceased. Its principal aim is to further the cause of safety among the million miners of the United States, Dr. Joseph A. Holmes having been conspicuous in the inauguration of the organized mine-safety campaign in this country. The association includes in its membership the Bureau of Mines, a considerable number of scientific and engineering societies, and various mine operators' and miners' organizations. The Holmes Safety Award Committee meets annually for the purpose of awarding certificates in recognition of exceptional safety records made by mines and quarries.

The awards just made, according to Dr. R. R. Sayers, chief of the Health and Safety Branch of the Bureau of Mines, and acting secretary of the Joseph A. Holmes Safety Association, are not necessarily meant to be in recognition of the best safety records made by mines and quarries, but are intended rather to commemorate exceptionally meritorious safety records which have come to the committee's attention.

Pyrites In 1926

The output of pyrites in 1926 was practically at the same rate as in 1925, decreasing from 170,081 long tons, valued at $650,448, in 1925 to 166,559 tons, valued at $616,668, in 1926, or a decrease of 2 per cent in quantity. The quantity sold or consumed by the producing company showed a larger decrease, from 170,298 long tons in 1925 to 163,217 tons in 1926. California and Virginia produced 95 per cent of the total output and New York and Ohio supplied the remainder.

Imports of pyrites in 1926 showed an increase of 32 per cent in quantity over 1925, from 276,385 tons, valued at $773,925, to 366,151 tons, valued at $856,981, and were the largest recorded since 1919. Of the total quantity imported Spain furnished 365,103 tons and Canada the remainder.

YOUR PLANT'S DAILY DOZEN

THERE is an old fable to the effect that a tiny mouse once saved the life of a huge lion That fable, for the non-metallic mineral producer, means "pay attention to the details." A few years ago a large Chicago printing establishment was compelled to stop its presses and close its doors, all because of an $18-a-week girl. The printing house had nearly completed an exceptionally large contract for mail-order catalogues. Paper had been purchased by the carload. Engraving and composition costs had been enormous. The work had been printed in colors, the "forms" gathered and bound and the books made ready for trimming. In this last operation the girl who operated the trimmer set the knife about a quarter-inch too far forward—and trimmed the printed prices off every article in the catalog, instead of merely trimming the edges. Firing the girl failed to keep this printing firm out of bankruptcy.

While the business of producing sand and gravel is somewhat removed from the printing business the story none the less illustrates the importance of details, the costliness of quarter-inches, and the apparent ease with which not only profits but sheer existence can be trimmed. In and about the preparation plant there are countless details that require constant watching if the ledger is to show black and not red. The photograph which is reproduced herewith illustrates the crushing and power end of a southern Illinois sand and gravel plant. By merely looking at the unretouched picture or by visiting a similar plant one could not tell how many or where the invisible "profit eaters" have their abode. To force home the importance of such details and the insidious menace of small leaks we have indicated by arrows a dozen places that are commonly found to be the abiding places of "profit eaters." Those indicated are by no means the only ones that infest the plant. They have been selected merely to afford a striking example of the losses that can and are being sustained by literally hundreds of such plants throughout the country.

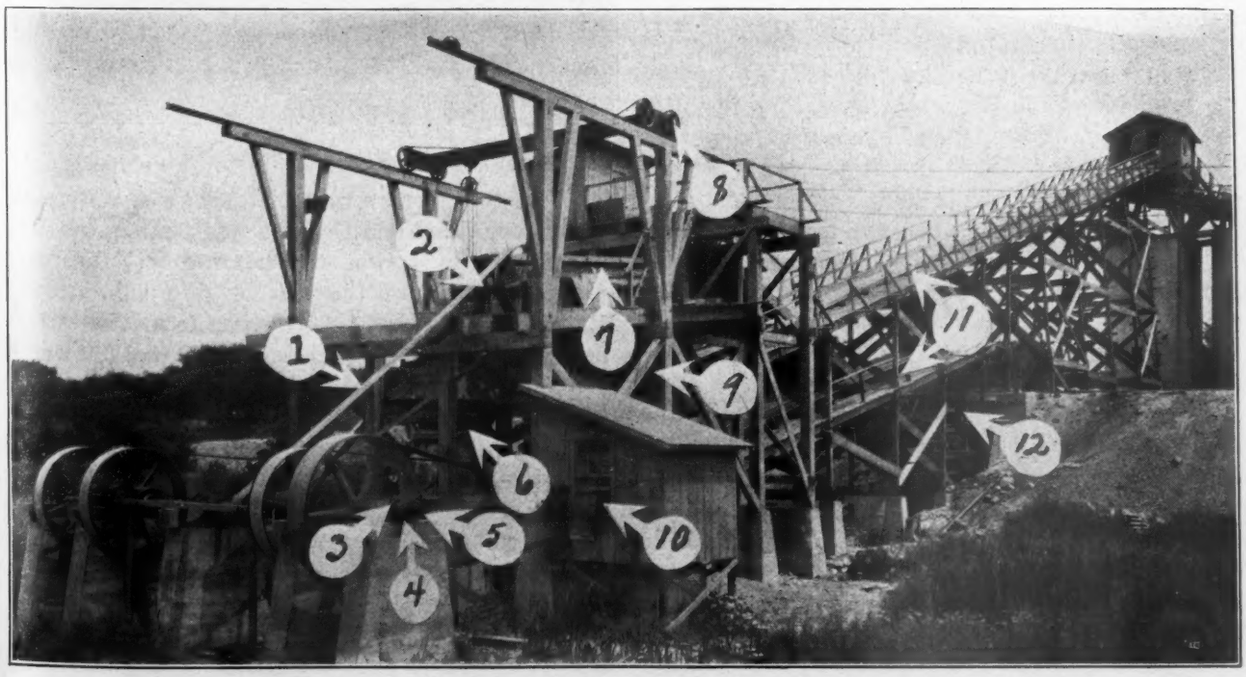
1. Slippage in transmission belts is a profit eater of a specie common to all plants, but more particularly to installations that are housed as this one—only by the great blue sky, which, not infrequently, is black with rain or white with snow. Belt slippage has been known to effect the loss of 38 per cent of the power produced. An 8 or 10 per cent loss is quite common. That is to say, one dollar out of every ten paid for power is lost in transmission—that it never reaches the machine.

2. Gears that have become worn or which may have a broken tooth or which do not mesh properly eat up power—and profits—with every revolution.

3. Inadequate or improper lubrication means you pay for worthless friction and unnecessary wear. Are you sure the men are giving the grease cups a frequent quarter- or half-turn? Are you sure the hard oil being used is the best for that particular bearing?

4. Bearings that have become worn or which have worked out of alignment are costly pieces of equipment to maintain. Such bearings can waste power equal to their initial cost as rapidly as twice a month.

5. Line shafts that are out of true require from 10 to 40 per cent more power than would be de-



Indicating A Dozen Places of Common Leaks

manded by shafts that are perfectly true and straight.

6. If the jaws or hammers of your crusher have become worn or broken there can be no assurance of efficient operation. Indeed, there can be quite definite assurance that the material is being handled twice instead of once.

7. Screens are subject to both wear and tear. Broken mesh means over-sized screening, improper preparation, and dissatisfied, perhaps lost, customers.

8. However small or minor the bearings, lack of proper lubrication means that you pay for what you don't get.

9. Electric wires do not have visible leaks as might a water pipe or valve. But wires too small for the load carried offer a resistance to the current that can be far more costly than any dripping faucet or leaky valve.

10. In this little housing there is a motor which should have, but frequently does not get, constant maintenance and care. Loosened stay bolts which permit vibration, too much or too little lubrication, and a score of other minor details may cause major losses.

11. By creating noise is the only way machinery has of telling its owner that it is wearing out. Not infrequently the squeal of conveyor belt rollers are heard—calling for adequate lubrication.

12. If the tension of this conveyor belt idler is not properly adjusted (and occasional adjustments are necessary owing to stretch and wear) power is being lost or excessive wear sustained.

Duff Abrams Resigns

The Portland Cement Association announces with regret the resignation of Duff A. Abrams, for many years director of the Research laboratory. Professor Abrams inaugurated the present-day research in concrete when he took charge of the Structural Materials Research laboratory in 1916. The research program, then begun, was supported by cooperation of Lewis Institute and Portland Cement Association. This joint arrangement continued until May, 1926, when the research laboratory was installed in the new headquarters building of the Portland Cement Association at 33 West Grand Avenue, Chicago.

Professor Abrams' work in concrete research is internationally known. His bulletins and scientific papers have been translated into many languages and are standard reference works in concrete technology. Prior to his connection with Lewis Institute, Professor Abrams was a member of the faculty staff of the University of Illinois, of which he is a graduate.

F. R. McMillan, manager, Structural and Technical Bureau, Portland Cement Association, has been appointed director of Reserch to have charge of all investigations in cement and concrete for the Portland Cement Association. Mr. McMillan has been a member of the headquarters and laboratory staffs since April, 1924. Prior to that time, for three years he was associate structural engineer with Adolph F. Myer, consulting hydraulic engineer of Minneapolis. He was also on the staff of the Turner Construction Company for some time and was in charge of concrete ship design for the Emergency Fleet Corporation, United States Shipping Board, during and subsequent to the war. For nine years Mr. McMillen was on the faculty staff of the University of Minnesota in charge of concrete design in the concrete laboratory.

H. F. Gonnerman

H. F. Gonnerman, associate engineer, Research laboratory, Portland Cement Association, has been appointed director of the laboratory. Professor Gonnerman joined the staff of the laboratory in 1922. Prior to that time he was in a private business in the far West and from 1908 to 1920 was on the faculty staff of the University of Illinois, of which he is a graduate. Professor Gonnerman is joint author of many of the Research Laboratory bulletins and while on the faculty staff at the university wrote a number of technical and scientific papers which received wide attention in engineering and technical circles. For many years he has been active in the American Society for Testing Materials and other technical and engineering societies. He is well known among engineers and research men throughout the country.

CONSTRUCTION FOR FEBRUARY SHOWS INCREASE

BUILDING and engineering contracts awarded during the month of February in the 37 states east of the Rocky Mountains amounted to $394,689,500, according to F. W. Dodge Corporation. This was an increase of 3 per cent over January and a decrease of 3 per cent from February of last year. The territory covered by this record includes approximately 91 per cent of the total construction volume of the country. Last month's contract record included the following important items: $164,374,000, or 42 per cent of all construction, for residential buildings; $67,986,100, or 17 per cent, for commercial buildings; $52,180,300, or 13 per cent, for public works and utilities; $41,247,000, or 10 per cent, for industrial construction; and $22,045,400, or 6 per cent, for educational buildings.

The February contract total brought the amount of work started since the first of the year up to $779,324,900, this being 10 per cent under the amount started in the first two months of 1926. Thus February's record indicated a real, though moderate, gain; since 1927 was 16 per cent behind 1926 at the end of January, and only 10 per cent behind at the end of February. Contemplated new work reported in February amounted to $630,580,100, being a 17 per cent decrease from the amount reported in January and a 27 per cent decrease from the amount reported in February of last year.

Southeastern States

Construction started last month in the Southeastern States (the Carolinas, Georgia, Florida, Tennessee, Alabama, Mississippi, Arkansas and Louisiana) amounted to $46,118,500. February's figure shows an increase of 9 per cent over January, but is 46 per cent under February of last year. Included in the month's construction record were the following important items: $12,586,900, or 27 per cent of all construction, for residential buildings; $11,985,000, or 26 per cent, for public works and utilities; $6,234,700, or 14 per cent, for industrial buildings; and $6,101,400, or 13 per cent, for commercial projects. A total of $88,436,900 was reached in the first two months of the year, being a decrease of 48 per cent from the first two months of 1926. Contemplated new work to the amount of $77,773,600 was reported in February. Decreases of 13 per cent from January and 56 per cent from February of last year are shown by last month's figure.

New England States

Building and engineering contracts let in the New England states during February amounted to $22,415,600. This figure exceeded January by 30 per cent and February of last year by 14 per cent. The more important items in last month's building record were: $9,452,600, or 42 per cent of all construction, for residental buildings; $4,859,000, or 22 per cent, for industrial buildings; $2,969,800, or 13 per cent, for commercial buildings; and $929,000, or 4 per cent, for religious and memorial buildings. New construction started in this district in the first two months of this year amounted to $39,598,400, being a decrease of 13 per cent from the corresponding period of last year. Contemplated work reported in February amounted to $35,162,900, which was 36 per cent under January and 2 per cent over February of last year.

Middle Atlantic States

Last month's building contracts in the Middle Atlantic States (Eastern Pennsylvania, Southern New Jersey, Maryland, Delaware, District of Columbia and Virginia) amounted to $41,146,800. There were decreases of 23 per cent from January and 9 per cent from February, 1926. Analysis of the February record showed the following items of note: $18,930,800, or 46 per cent of all construction, for residential buildings; $5,582,900, or 14 per cent, for commercial buildings; $4,451,500, or 11 per cent, for educational buildings; and $4,389,000, or 11 per cent, for public works and utilities. Total building contracts for the first two months of this year, amounting to $94,590,300, show an increase of 18 per cent over the corresponding period of 1926. Contemplated new work reported last month amounted to $102,803,300. The above figure shows a decrease of 12 per cent from January and a gain of 48 per cent over February of last year.

Record February in Pittsburgh Area

February building contracts in Western Pennsylvania, West Virginia, Ohio and Kentucky amounted to $56,696,100. This was the largest February on record for this district. It was 13 per cent over the preceding month and 23 per cent over the corresponding month of last year. Included in the month's record were: $17,788,500, or 31 per cent of all construction, for residential buildings; $16,221,000, or 29 per cent, for commercial buildings; $8,145,200, or 14 per cent, for public works and utilities; and $6,685,600, or 12 per cent, for commercial buildings.

Construction started in the Pittsburgh district during the past two months has amounted to $106,753,800, being an increase of 26 per cent over the first two months of 1926. Contemplated new work reported in February amounted to $62,468,200, being 25 per cent under the amount reported in January and 5 per cent less than February of last year.

Largest February on Record for Central West

The Central West (Illinois, Indiana, Iowa, Wisconsin, Southern Michigan, Missouri, Kansas, Okla-

homa, and Nebraska) had $109,733,000 in contracts for new construction work during February. The above figure is the largest for any February on record. There were increases of 30 per cent over January and 29 per cent over February, 1926. The more important items in February's building and engineering record were: $42,258,000, or 39 per cent of all construction, for residential buildings; $18,700,000, or 17 per cent for public works and utilities; $15,513,400, or 14 per cent for commercial buildings; and $9,710,100, or 9 per cent, for social and recreational projects. The combined total for the first two months of this year $194,433,600 shows an increase of 18 per cent over the corresponding period of 1926. Contemplated new work planned for the Central West as reported in February amounted to $183,701,100. This figure is 14 per cent under January and 30 per cent under February of last year.

New York and Northern New Jersey

February building contracts let in New York State and Northern New Jersey amounted to $103,591,800. The above figure shows decreases of 13 per cent from January and 1 per cent from February of last year. Included in last month's record were: $56,625,500, or 55 per cent of all construction, for residential buildings; $28,816,600, of 28 per cent, for commercial buildings; $5,377,400 or 5 per cent, for public works and utilities; and $3,652,400, or 4 per cent, for social and reactional projects. The combined total for the first two months of this year, $222,328,200, shows a decrease of 26 per cent from the first two months of last year. Contemplated new work reported in February amounted to $129,225,900. This figure represented declines of 24 per cent from January and 40 per cent from February, 1926.

The Northwest

February building and engineering contracts reached a total of $2,871,400 in Minnesota, the Dakotas and Northern Michigan. This figure exceeded January by 15 per cent, but declined from February of last year by 46 per cent. Analysis of last month's building record showed the following items of note: $1,648,600, or 57 per cent of all construction, for residential buildings; $349,000, or 12 per cent, for educational buildings; $267,700, or 9 per cent, for commercial buildings; and $205,300, or 7 per cent, for industrial buildings. The total amount of work started during the first two months of 1927 is $5,362,200, a decrease of 42 per cent from the first two months of last year. Contemplated new work reported for this territory during February amounted to $7,775,700. There was an increase of 2 per cent over January, and a loss of 40 per cent from February, 1926.

Texas

Texas had $12,296,300 in contracts for new building and engineering work last month. There were decreases of 21 per cent from January and 24 per cent from February, 1926. February's building and engineering record included the following important items: $5,084,000, or 41 per cent of all construction, for residential buildings; $2,822,200, or 23 per cent, for public works and utilities; $1,958,700, or 16 per cent, for commercial buildings; and $866,400, or 7 per cent, for industrial projects. New construction work started in Texas in the first two months of the year amounted to $27,821,500 being a decrease of 7 per cent from the corresponding period of 1926. Contemplated construction projects are reported for Texas in February to the amount of $31,669,400, which increased 56 per cent over January and 27 per cent over February of last year.

In making a primer, the first consideration is that it can be loaded safely, the second that when the primer is loaded the detonator will be firmly anchored in the primer cartridge, and the third that there shall be no sharp turns or kinks in the fuse that would be likely to pinch the powder core of the fuse. Another consideration is to load the hole in such a manner that there would be a minimum opportunity for side spitting fuse to ignite the charge. Side spits are more likely to ignite a charge if the flame of the side spit strikes unprotected explosive rather than the paper wrapper of the cartridge.

What the World War Cost Industrially

Worthy statisticians say that the shortage in international trade because of the World War amounts to $200,000,000,000. This is the total value of merchandise exports which would have been added to international trade had there been no World War and is based on reliable figures from 70 nations which do more than 90 per cent of the world's business. Only last year, it seems, did the world get back to the 1913 basis. The nations under discussion had an export trade of $19,426,000,000 in 1913. Last year the total was nearly 30 billions, but at the 1913 buying power this amounts to only 20 billions, or just slightly in excess of the 1913 figure.

"The amount of world trade there would have been if there had been no war," the report says, "was reckoned by the rate of advance from 1900 to 1913, which amounted to 6½ per cent annually. To meet the setback caused by the war, world trade has not accelerated in pace, and for the last three years the advance has been more than 10 per cent annually. But even at this rate, it will take 30 years to make up for what has been lost."

"Even this country, which has gained almost 32 per cent in real exports since 1913, and has made the greatest gain of all nations in volume of trade acquired, is still more than $2,000,000,000 behind the export trade it would have had if the pre-war gain had been uninterrupted."

PIT AND QUARRY FOREIGN DIGEST

Influence of the Burning Process On Portland Cement

The results of the investigation can be correlated either with the Nacken-Dyckerhoff or the Kühl theory. In accordance with the former, (1) all clinker burned under 1270 degrees C. must break up on account of the defects of the residual melt. (2) From that point on at which the saturation of the beta dicalcium silicate with CaO is completed, as well as about 20 minutes duration of sintering at about 1,350 to 1,400 degrees C., the strength remains invariable even after higher and longer heating. (3) Great rapidity of cooling increases the strength. (4) Aside from slight thickening, no change in appearance of the clinker occurs after 1,300 degrees C. has been passed.

In accordance with Kühl's theory the following results were obtained: (1) Clinker burned under 1,340 degrees C. exhibits poor setting and curing properties, and deficient hardening power. (2) The strength of cement is certain to be improved with each advance in the burning reaction. (3) It cannot be said with absolute certainty that the amount of melt must be increased although, to be sure, according to Kühl's views, material is always going into solution and also crystallizing out again after the reaction has occurred. But in every case the reaction must be carried to a very great thickening of the material. (4) Rapid cooling makes for improvement of the strength, for the presence of solid dissimilar masses in Portland cement clinker raises its quality. E. Ullrich—(Zement. Vol. 16, pp. 72-74 and 91-94, 1927).

Influence of Potash Pit Liquors On Cement Properties

Ore cement shows the greatest resistance against the effect of the usual salts. Neither fissures nor great efflorescence occurs. So far as the effect of the salts on portland cement and Aluminous cement the content of magnesium chloride in the salts was decisive. Only salts containing $MgCl_2$ exhibited blowing or strong efflorescence. H. Burchartz. (Zement. Vol. 16, pp. 77-83, 1927).

Silicic Acid Lime Alumina System

The ternary system lime, alumina, silicic acid is of great importance in technology. The investigations covered first the three binary systems of the pure substances, then the ternary system and after that the technically important materials such as blast furnace slag and smelter cements, Portland cements, natural cement, aluminous cements and other substances. The physical properties are treated briefly. R. Grun. (Naturwissenschaften 14, 869-73, 1926).

Various Cements in Potash

The behavior of various cements with the potash liquors encountered in that industry was investigated with the object of determining which cement best resisted these solutions. The conclusion reached was that a cement poor in lime, such as blast furnace cement, resisted the liquors best; but its resistance was increased if portland cement, which also shows a definite resistance to the potash liquors, is mixed with it. A blast furnace cement of not too great clinker content with the addition of about 10 per cent trass was considered the most suitable for use in the potash industry. Calame (Kali 20, 328-36, 1926).

Free Silicic Acid in Feldspar

The free quartz particles mixed with feldspar effect an increase in melting point. Its detection is difficult, as well as the microscopic examination, for its similarity is great. To differentiate, the feldspar is heated to 1,200 degrees at which point it melts without dissolving the quartz, which solution occurs only at 1,300 degrees C. The test piece is finely powdered, set in Canada balsam and examined under the microscope. The feldspar particles are isotropic. The number of grains of the same pulverized material is determined in ordinary and then in polarized light. The number of particles are calculated in per cent. The analysis requires three to four hours. L. Schaetzer (Ceramique 29, 301-2, 1926).

Testing of Fireproof Materials

By investigation of three fireproof stone building materials in 13 different laboratories, it was thoroughly demonstrated that the present procedure employing the pressure softening method is not uniformly applied. Comparative results are not to be obtained in investigation stone materials by the different testing methods. Miehr, Knuth & Konig (Tonindustrie Zeitung 50, 1527-31, 1926).

Fireproof Plastic Composition

A composition which is suitable for use as a wood substitute, which is incombustible and an electric insulator, is made by adding mixed solutions of sodium and potassium silicates containing an excess of silica to a mixture of mica, asbestos and lime. Kaolin and lime glass may replace some of the mica. A small proportion of saw-dust may be added to prevent too rapid hardening of the surface; the addition of glue renders the product softer and less porous. The composition is molded and dried at a temperature of less than 200 degrees C. J. Gallet (British Patent 261,357).

Aluminum Oxide

Residual metallic oxide impurities are removed from the hollow globules of aluminum oxide, by leaching them with or without a preliminary crushing and grinding, with an acid reagent, and then washing them, preferably being conducted on the counter current principle in a series of classifiers of known type. H_2SO_4, HCL, HF, and sulphurous acids and acid sodium sulphate are specified as suitable acid reagents. The impurities, comprising lime, iron oxide, silica and tintanium oxide are removed partly in solution and partly in suspension. Examples of the treatment, and the direct treatment of the slag from which the hollow globules of aluminum oxide are obtained are described. Aluminum Co. of America (British Patent 262,405).

Porous Bricks

Sawdust or other fibrous material which is to be mixed with clay and subsequently burned out to leave a porous body is heated to a temperature of 200 to 325 degrees C. either before or after admixture with the clay but before moulding the mass. The heating is of sufficient duration to volatilize organic compounds which would otherwise cause rupture of the brick by their volatilization therein during the burning. A porous siliceous substance such as fuller's earth, kieselguhr or a colloidal siliceous substance such as silicic acid, bentonite, etc., may be added to the clay. Kern and Kern (British Patent 262,826).

Sand Moulding Machines

Sand is packed in a flask by substantially continuous vibration. In order to effect this the flask, filled with sand, pressed down with a weight, is placed on a table resting on a frame, and a series of rapid blows is applied to the table by an impact piece and a piston, which reciprocates in a cylinder when air is supplied through a pipe.

The supply ports are covered alternately by pierced flanges and the exhaust ports are opened to each end alternately. The downward blow is cushioned by a cup-shaped piston supported by oil under pressure. J. T. Stoney (British Patent 262,850).

Slag Cements

The slag resulting from the fusion of phosphate, sand, and carbon with elimination of phosphorus or its oxides is converted into cement by additions of calcareous, aluminous or like materials, after it has left the furnace. The additions are made to the slag while it is still in a molten state, but the mixture may undergo a further fusion if necessary. The process is applicable alike to the production of portland cement and of alumina cement. I. G. Farbenindustrie A. G. (British Patent 263,124).

Mixing Machines

A portable concrete or like mixing-machine, and more particularly a rotary batch-mixer of the type employing an open drum which rotates about an inclined axis during mixing, and is tilted either sidewise or endwise to discharge the aggregate, is carried on caster wheels each of which is mounted in a swivel with its axis offset radially with respect to the axis of the swivel, which is attached to the main frame of the mixer to provide the desired castering effect. D. Whitaker (British Patent 262,518).

Aluminous Cement

In addition to the technique already known for the use of this material the following conditions must be remembered. Do not make concrete with aluminous cement with instruments coated with another variety of cement. Do not permit the work to be exposed to the full heat of the sun without a cover. Do not employ it under water, or in excavations where after draining the water may resurge rapidly enough to cover the concrete before it has set. Quinquet. (La Revue Generale des Chemin de Fer and Le Ciment. January 1927. p. 15-17.)

Rock Grinding Phenomena

When a product composed of homogeneous rock structure is ground the resulting ground material contains percentages of various particle size which follow a well defined mathematical law. This is not true for non-homogeneous structures. In the disintegration of homogeneous rock the grinding occurs as often by transverse rupture as by wearing away of the surface, except in the case of ball mills where the relation between the diameter of the grains to that of the balls exceeds a critical limit. A. M. Gaudin. (Revue de Metallurgie et Le Ciment. Jan. 1927.)

Manufacture of Cement

In the manufacture of cement by the wet method in a rotary kiln, a higher kiln output is attained by spraying the slurry into the kiln, thus reducing its water content to about 10 per cent before it is deposited on the wall, and preventing the formation of "slurry rings" or large masses. One or more sets of long sprays are employed, originating outside the kiln, and disposed at such an angle to the axis that even if projected several feet into the kiln the spread is not greater than the internal diameter of the kiln, so that the moist slurry is gently deposited on the wall. Slurry lifting or agitating gear is provided internally only beyond the region where the atomized material is mainly deposited, and a scraping device is added, which, during rotation, frees the kiln mouth from deposit. Rigby (British Patent 261,814. Brit. Chem. Abst. Vol. 46, p. 76).

Concrete by Dry Charging

The procedure employed for the works of the port of Anvers, permits the mixing of large quantities of concrete without interruption. The charging is done dry in a sort of hopper, at the bottom of which is a travelling belt moving horizontally. The hopper comprises three compartments: The first filled with sand, the second with gravel and the third with sand. The belt operates the first compartment and the latter the other two. At the outlet of the third compartment lies the stratified material where it receives the cement and trass furnished by a rotating feed box. Following this the whole is mixed by a rotating mixer. All the rotating shafts are integrated in the same movement which keeps the charging constant. The mixture then falls into an inclined rotating cylinder in the interior of which there is arranged a row of sprinklers. The concrete may then be used immediately. Anon. (Le Genie Civil.)

Slag Cement in Sea Water

Slag cements have shown great resistance to attack by sea water. This property is due to the relatively small amounts of lime contained in them and the large amounts of active silica as compared with Portland or iron Portland cements. The slag cements have given excellent results in particular the abutments of the mole at Wilhelmshaven built in 1914; eleven years later, in August, 1925, there was no sign of disintegration. This was true also of the portions located between high and low tides, where they were subjected alternately to the action of air and sea. Anon. (Tonindustrie Zeitung.)

Cements, Mortars, Etc.

This invention relates to the treatment of salts, such as calcium chloride, which are used to accelerate the setting of cements and mortars or to activate substances such as slags which possess latent hydraulic properties, and consists in impregnating the salts with a colloid such as gelatinous silicic acid to render them resistant when being stored. Oxides such as lime and retarding agents such as calcium sulphate may also be added to the mixture. According to one mode of procedure solid calcium chloride is added to a solution of silicic acid until a dry mass which can be ground is obtained. According to another method the mixture of calcium chloride and silicic acid is obtained by dissolving portland cement or the like in hydrochloric acid and evaporating to dryness with or without the addition of lime, calcium sulphate, etc. The product is preferably mixed with cement during the grinding of the latter. C. Schneider (British Patent 262,294).

Porous Concrete

A porous clay clinker is used as an aggregate in concretes of the type which are rendered porous by the injection or generation of gas within them. One kind of clinker is produced by heating the clay to a temperature just above the sintering point and interrupting the heating before the material commences to shrink. Another kind of clinker is obtained by heating the material at increasing temperatures until it melts to a viscous mass. E. I. Lindman (British Patent 262,394).

Refractory Substances

A refractory article consists of hollow globules of a fused refractory oxide, particularly alumina, cemented together by means of a binder such as sodium silicate, sodium or calcium aluminate, clay, etc. The binding agent preferably contains a considerable proportion of the oxide forming the globules. Crushed refractory material may also be added to the composition. The globular material may be obtained by subjecting the fused oxide in a relatively thin stream to the action of a transverse air or steam jet. Aluminum Co. of America. (British Patent 262,403).

Volcanic Stone Castings

In the production of castings from volcanic rocks or slags the temperature is so regulated that the more infusible crystalline particles do not melt, but remain as inoculation centers for the recrystallization of the remaining material. Further quantities of infusible crystals may be added to the melt to increase this effect. C. Kruger (British Patent 262,413).

Progress in Cements

Of the new cements introduced commercially in recent years, the best known are the aluminous of which Ciment Fonder is representative. The three most important properties from the engineer's standpoint, are very rapid hardening, high mechanical strength and ability so far as has been proved to resist the chemical action of sea water. These cements are valuable in precast work, and foundation construction and road work. "Rapid Hardening" Portland cement has somewhat similar properties to the aluminous cements. It is, however, considerably cheaper, and its use is being greatly extended especially in road making. Slag cements have not as yet made very much headway, their development, however, seems to be assured, although many years have elapsed since the production of this class of cement was first undertaken. The British Engineering Standards Association have recently issued a new specification for Portland Blast furnace cement in which the minimum proportion of Portland cement clinker is fixed at 35 per cent. H. J. Deane (The Structural Engineer, London. Vol. 5. p. 50-56. 1927.)

PRESENT STATUS OF AGRICULTURAL LIMING IN THE MIDDLE WEST

By G. P. Walker

TIMING of the acid soils of the middle west is the most important factor in their improvement. The use of liming materials for this purpose has increased to the point where a vast quantity is required to supply the annual demand. Illinois, with a total cropped area of twenty million acres, through her limestone-sweet clover program has reached an estimated yearly consumption of around 800,000 tons. Ohio with a cropped area of a little less than twelve million acres is now using something over 200,000 tons and Indiana, with a similar cropped area, about 200,000 tons.

Due to its low cost and wide distribution throughout these states ground limestone is by far the most important of the liming materials used on land. Most of the stone used for this purpose is by-product screenings, shipped in bulk, which are often furnished the farmer at a price f. o. b. the quarry considerably below the freight cost of delivery. Practically all the demand for agricultural stone comes in August and September. That is the season when most farmers have time for hauling and spreading it and the stone is usually dry and in good condition for spreading. Many companies are finding it impossible to fill their orders during this rush period. At the same time there is a growing feeling among farmers that they want less of the coarser screenings than they have been obliged to use in the past and a number of producers are now using three-eighth inch mesh screens instead of the one-quarter inch in order to meet this demand for finer material. Field experiments of the experiment stations in Ohio and Indiana show this to be desirable as the finer stone gives better results over a series of several years. The general tendency is in this direction.

To meet any further increase in demand the selling period must be extended to include more than eight cr ten weeks in the fall or sufficient additional grinding equipment provided for taking care of orders during the rush season. The latter would naturally tend to raise the cost of the stone at the quarry which would not be desirable. Theoretically limestone may be hauled and spread at any time during the year, winter as well as summer and winter liming has been encouraged as a means of helping the situation. However, most agricultural stone is shipped in gondola cars and one experience with a car of wet frozen stone or soft thawed out roads upon its arrival is enough to disgust an entire neighborhood with winter liming.

A practical plan for extending the shipping period has been worked out by Frank Goodwin of Crawford county, Illinois, who has limed a total of 700 acres of land since 1913. He orders his stone by long distance phone at night along in late spring or early summer at a time when the ground is too wet to cultivate for a couple of days. The producer gets his car rolling the next day and the following morning it is set on his local siding ready for unloading. To save time in unloading the car he dumps the stone in the nearest corner of the field to be limed, usually a field that is in wheat or oats. Later after he has finished cultivating corn and is through threshing he can take advantage of any slack time in his farm work for spreading the stone. In this way he avoids the delay that usually results if the order is deferred till the time when the producers are in the midst of their greatest rush of business.

Mr. Goodwin's plan for saving time and some of the hard work in spreading the stone over the ground is simple but effective. He uses two wagons and a centrifugal type of spreader mounted on two wheels which may be attached to each wagon by means of a hook in a stub tongue and a ring in the end of the wagon coupling pole. One man scoops the stone into the spreader hopper, another drives the team, while a third man loads the extra wagon at the pile. They start spreading each load near the pile, driving around the outside of the field until the load is all spread. In this way the double load on the team of stone and spreader operation is rapidly reduced as they proceed across the field. The team gets some rest from the steady pull on the return trip to the pile and the men take turns driving and scooping. By this method about 15 acres can be covered in a day rather easily at a relatively low cost. The adoption of some such scheme as this by more farmers throughout the middle west would simplify the liming problem not only for them but also for the producers.

Thoughtful Tips

If you want to get ahead use the one you have.

Your value to your company depends upon how little supervision you require.

A lazy man is of little more use than a dead one and he takes up more room.

Long experience has demonstrated that the most profitless thing to manufacture is excuses.

Have you ever noticed that most of the lucky fellows are hustlers?

New Foote Distributors

Foote Bros. Gear & Machine Company announces the following additions to its distributors organization. The Interstate Machinery and Supply Company, Omaha, Nebraska, has been appointed as representatives for IXL products in Omaha, the eastern half of the State of Nebraska and the west portion of Iowa. Mr. W. L. Hutcheson, Oklahoma City, Oklahoma, has been appointed for Oklahoma City and the northern half of the State of Oklahoma. Nashville Machine & Supply Company, Nashville, Tennessee, has been appointed for Nashville and the central part of the State of Tennessee. Hollis & Company, Little Rock, Arkansas, has been appointed distributors for the city of Little Rock and vicinity.

Luther G. McConnell Resigns from North American Cement

Luther G. McConnell has resigned as Vice-President of the North American Cement Corporation to become an officer of a New York bank. Frederick A. Boeye was made Vice-President, also continuing as General Sales Manager and Thomas J. Haite becomes Assistant General Sales Manager.

Here's The Difference

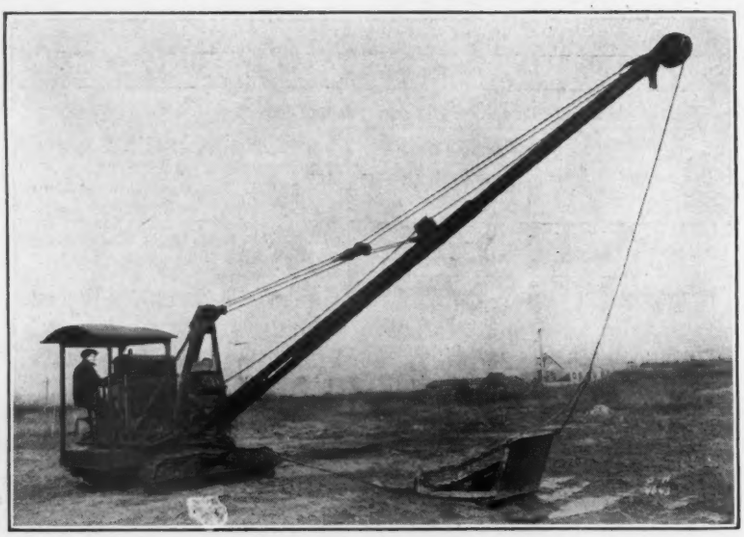
THE FULL-REVOLVING QUARRY SHOVEL (360° *Swing*)			THE RAILROAD SHOVEL *With Less Than 180° Swing*		
120-B (4 Yard)	**100-B** (3 Yard)		**103-C** (3½-5 Yard)	**88-C** (3½-4½ Yard)	**78-C** (2½-3½ Yard)
29′ 0″	25′ 6″	Radius of Clean-up on Quarry Floor (*Dipper at 15°*)	20′ 0″	19′ 6½″	18′ 4″
20′ 6″	17′ 0″	Clearance Between Caterpillars (or Jack Arms) And Edge of Level Floor	8′ Approx.	8′ Approx.	7′6″ Approx.
38′ 0″	37′ 0″	Radius of Dump	31′ 9″	30′ 3″	29′ 7″
1-Man	1-Man	Pit Labor	4 or 5 Men	4 or 5 Men	4 or 5 Men
1-Operator 1-Oiler (or Fireman)	1-Operator 1-Oiler (or Fireman)	Shovel Crew	1-Operator 1-Fireman (or Oiler) 1-Craneman	1-Operator 1-Fireman (or Oiler) 1-Craneman	1-Operator 1-Fireman (or Oiler) 1-Craneman
Single Truck Caterpillar	Single Truck Caterpillar	Mounting	Railroad Trucks and Jack Arms or Caterpillars Front and Rear		
Overcasts		Handling Oversize	Must wait for Block Holing — or Gets them in next to the Bank		
Low Cost (Oversize block-holed behind the shovel)		Shooting Oversize	(Block Holing in front of Shovel) High Cost		
No Lost Time		Moving Up	(Railroad Track Mounting / Caterpillar Mounting) Much Lost Time / Little Lost Time		
Rapidly		Backing Away from Blasts	(Railroad Track Mounting cannot / Caterpillar Track Mounting Slow		
Can move to part of face where blast was effective		In case of Poor Shooting	Must wait for Secondary Blasting		

The above table illustrates the detail difference between the full revolving quarry shovel and the railroad shovel with less than 180 degree swing. Models of the two machines compared are shown in the illustration below.

A novel exhibit of the Bucyrus Company at the recent Convention of the National Crushed Stone Association showing the contrast between the Old Railroad Shovel and the Full Revolving Shovel. The entire exhibit was on a scale of ¾ of an inch to the foot and the Quarry face is 40 feet high.

New Harnischfeger Machine

The Harnischfeger Corporation announces a new, improved type of backfiller. The construction of this new model is consistent with that of their new line of all steel excavators, being also built on a foundation of unit cast steel construction. All shafting is in the same plane thus making it a simple matter to renew any shaft or gear thereof.



New Harnischfeger Backfiller

The lever arrangement has been simplified to four levers instead of seven as has been the usual custom heretofore. The boom hoist and swinging is power controlled through a worm and worm gear. The boom can be swung through 180 degrees. The hoist speed is 300 feet per minute while the dragline speed is 150 feet per minute. As a clamshell it handles a ¼ yd. bucket. The lifting capacity at 15 feet is 2,000 lbs.

The hoist line fairlead is adjustable and consists of five ball bearinged rollers of large diameter which are used for crane and clamshell work as well as for backfilling work. Each drum is provided with an independent foot brake. The scraper is unusually sturdy, being pressed from heavy plate metal. The angle of the scraper plate and also the pulling chain is adjustable to take care of the various soil conditions. The boom is of lattice and is adjustable from 22 feet to 30 feet in steps of 18 inches. Steering brakes are foolproof and can positively be locked. A sheet metal canopy over operator and machine and another over engine are provided as standard equipment. The operator's view is unobstructed by gears or any other parts of machinery. All machinery on this new model backfiller is completely guarded.

New G. E. Developments

The General Electric Company has recently developed a line of medium speed Synchronous motors, 7600 series in the following types: TS, 3 phase and QS, 2 phase, operating from 514 to 900 r.p.m. and in horse powers 100 to 700 with 220, 440, 550 and 2,200 voltage. These motors are described in bulletin GEA-708.

Types TS and QS motors are adapted for general purpose application and will drive any load whose torque requirements have been successfully met by a standard squirrel-cage induction motor. These motors meet every standard and requirement of general purpose synchronous motors as adopted by the National Electric Manufacturers Association. The starting torque is therefore as great as that of the standard squirrel-cage induction motor of the same rating. The starting current corresponding to full load starting torque is not greater than 4½ times rated full load current. At full rated voltage, the motor will deliver more than 100 per cent torque up to 95 per cent of synchronous speed; therefore it is able to synchronous under full load conditions.

Bulletin GEA-588 describes new G. E. gears for centrifugal compressors. These gears are used to step up the speed of the prime mover to that required for the compressor. The higher speeds made available by the gear have not only increased the efficiency of the compressor, but, by permitting a reduction in size, have decreased the cost. The wide range of compressor speeds required to meet the numerous combinations of volume and pressure and the comparatively limited motor speeds would require a considerable amount of special development to meet each customer's requirements were it not for the wide adaptability of the gear. By the simple expedient of changing the ratio, a given size of gear unit can be made to cover a large range of horsepowers and speeds to cover the entire range. The units have been developed in several sizes, with horspowers up to 3600 and speed ratios as high as 9 to 1.

This company has also designed and are manufacturing a line of automatic control panels for industrial electric heating which are illustrated in bulletin GEA-594. These control panels are made in two types; the open type and the enclosed type. They are available in various capacities, for all standard power circuits. Panels for mounting temperature control instruments are made in various widths to correspond with the automatic control panels with which they are used. For wall mounted automatic control panels, a type of wall mounted instrument panel of the same width as the control panel is available.

For floor mounted automatic control panels, the instrument panel of the same width as the control panel is arranged for floor mounting directly beneath the control panel but on separate supports. On the smaller sizes of floor mounted control panels, 135 amperes or less, the instrument panel can be supplied with facilities for mounting on the supports of the automatic control panel. This latter practice is not recommended with larger control panels because the movement of the larger contractors has a tendency to set up a vibration which could be transmitted to the instrument were its panel mounting on the control panels supports.

Du Pont Moves N. Y. Office

The New York office of the explosives department of E. I. du Pont de Nemours & Company, which company has been in existence for a century and a quarter, will move from its present quarters in the Equitable Building to the Graybar Building just East of the Grand Central Terminal toward the end of April. The Equitable and Graybar buildings are the two biggest office buildings in the world.

New Novo Distributors

The Novo Engine Company has added the following concerns to its list of authorized distributors: Contractors Sales Company, Inc., Albany, New York; The Wheeler Murray Company, Rochester, New York; McCraken-Ripley Company, Portland, Oregon, and The Hudson Supply and Equipment Company, Washington, D. C.

Weigh As You Load

The past few years have seen a revolution in storage equipment among dealers and producers in sand, gravel, stone, slag, coal and all other granular materials. In this age of steel, the tendency has been toward bins made of steel and there has been almost a complete departure from the cumbersome, costly and expensive to maintain, wooden bin.

This change in type of storage equipment is only natural and it has required little effort on the part of bin manufacturers to convince users of bins of the economy of steel. It is a known fact that the only upkeep expense on a steel bin is an occasional painting about every three or four years, because steel will, of course, rust unless taken care of in this manner. Heretofore, it has been the bin user's worry to go to the trouble of designing a bin and building it of heavy cumbersome timbers, which in this day are an expensive item, and he has thereafter been faced with the necessity of replacing rotted sections of the wooden bin. The development of the steel bin has eliminated all of this troublesome planning by making available a complete line of steel bins of standard sizes, and capacities to meet every possible storage condition.

One of the popular types of bins among the users is the circular steel bin. The main storage portion of this bin is a steel tank, circular in cross-section and the manufacturers have been better able with this type of construction to meet the requirements of portability and easy erection. This popularity is due to the fact that circular steel bins with their smooth, steep, sloping sides and their hopper bottom construction, facilitate the flow of material from the bin by gravity. The self-cleaning feature of circular bins makes all storage alive, there being no ledges, bolts or rivets on the inside of the bin to retard the flow of material. The fallacy and extravagance of a large amount of dead storage overhead has been demonstrted repeatedly where flat bottom and make-shift designs of hopper bottom wood and concrete bins have been used.

Every user of bins has had trouble and grief with strike off gates and until the past few years has had no other recourse than to make the best of his own make-shift designs, or a few other poorly designed gates which he might have been able to buy. Now there has been designed the roller bearing "No Jam" gate. This is a roller bearing gate which operates with ease and speed by a lever or rack and pinion mechanism, either from the ground or an elevated platform, or from any other convenient point.

The practice of batching aggregates for concrete at material yards has grown to enormous proportions and nearly all modern bin installations include equipment for measuring accurately the fine and coarse aggregates and loading the batches into the contractor's trucks for delivery to the concrete mixer. In some instances, material yards sell the aggregate batches and deliver to the concrete mixer or paver. Batching of aggregates at material yards has proven to be a most advantageous method of marketing the materials.

Measurement by volume is the original form of measurement used for concrete aggregates and this has been accomplished by equipping many of these bins with adjustable measuring batchers which are accurate, reliable and quick and easy to operate. These batchers are of sturdy, and durable construction, have a wide range of capacity, and are arranged for a rapid change of adjustment.

The "Weigh as You Load System" is a unique development in material yard methods. When this system is used, a weighing batcher measures the material accurately by the pound before it is loaded into the truck. One operator controls the plant and loads all trucks. The truck drives in and is loaded with the desired weight of material and is then ready to make delivery. There is no loss of time or congestion of trucks and there is no overloading or underloading. A weighing batcher eliminates the platform scales and there can be no freezing of scales or damage to the weighing equipment due to the impact of heavy trucks. The tare weight of a truck, gasoline, etc., does not enter into the weight of the load in the "Weigh as You Load System." Approximate weights or guess weights are avoided. Congestion of trucks awaiting their turn on the platform scales is eliminated and there is a definite saving of truck time and labor.

Gas Engine Driven Welder Announced by G. E.

The General Electric Company announces another addition to its line of welding equipment, a small engine driven welding outfit. This set incorporates the G. E. WD-11 welding generator with a continuous rating of 150 amperes and a one-hour rating of 200 amperes, the current range running from 50 to 250 amperes.

The generator is driven by a Continental P-20, power unit rated at 18.22 horsepower and capable of developing 23.5 horsepower at 1400 r.p.m. The generator is equipped with a control panel, rheostat and self-adjusting stabilizing reactor. The engine accessories include a strongly constructed radiator, pressure feed lubricating system with oil pressure gauge and indicator, vertical tube gravity feed carburetor, air cleaner, centrifugal governor, starting crank, 10-gallon gasoline tank, tool box and sheet metal hood with sheet metal side panels which can be locked in place.

Among the advantages of this combination are low first cost, light weight and reliability. Tests have shown the outfit capable of standing up under hard service and overloads. The set is mounted complete on a structural steel base so designed as to facilitate easy moving from place to place.

New Novo Pumps

The Novo Engine Company are now producing the new Flud Oild enclosed self-oiling, one, two and three cylinder piston pumps. These units are described in catalog number 140. The single cylinder enclosed piston pump is a double acting, inside packed pump, powered with Novo one and two cylinder gasoline engines or electric motors. All working parts—gears, pinions, crosshead and bearings are automatically lubricated and run in a bath of oil. The two cylinder enclosed piston pump is a double acting inside packed pump, powered with Novo one and two cylinder gasoline engines or electric motors. All working parts, gears, pinions, bearings and crossheads are automatically lubricated and run in a bath of oil.

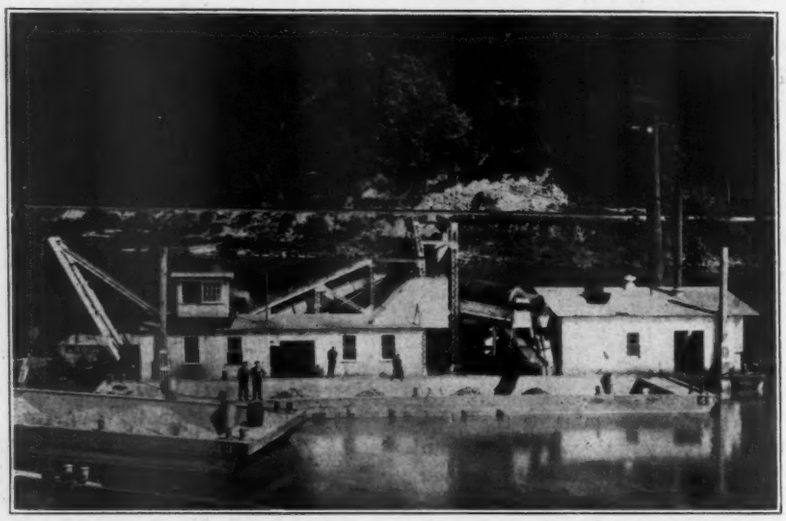
The triplex pump is particularly for road builders' use, being the proper size unit to operate with a 28E paver. Capacity up to 70 gallons per minute at 500 pounds pressure. It is powered with Novo NF, 25 hp. four cylinder engine and is mounted on steel truck. These pumping plants with all gears, pinions, crossheads, pins and bearings enclosed in an oil tight case, are automatically lubricated. Pumps have no grease cups. They will operate even in isolated places with a minimum amount of attention.

Ross Island Sand and Gravel Appoint New Sales Manager

We have been advised that Henry Foott is now sales manager for the Ross Island Sand and Gravel Compay. Mr. Foott has been identified with the sand and gravel industry for the past 17 years, the last eight of which were with the Hackett Digger Company.

Allegheny River Sand Corp. Using Metal Dredge Boat

Lifting sand and gravel for industrial uses at the rate of three tons a minute is the task of a large sand and gravel dredge of the Allegheny River Sand Corporation near Mahoning, Pennsylvania, just north of Kittanning, Pennsylvania. This metal dredge has a capacity of three tons a minute or almost 200 tons an hour. In operation a ladder bucket reaches down into the river and brings the material to the surface. The bucket can be lowered by the boom to a depth of thirty-seven feet. When the bucket loaded with sand and gravel has been drawn up, the material is carried on an incline and emptied into a rotary screen for grading. Here the sand is sifted out and the gravel is sorted according to size into barges alongside. The task of bringing the material to the surface is handled by a powerful 175 h. p. steam engine.



Metal Dredge Boat Built by the Midland Barge Company

The cabins which enclose the engine, the boiler, and the controls are built of Armco galvanized sheet metal. Such metal dredges now bid fair to replace the old-fashioned wooden dredge boats because they are more durable and fireproof. The known resistance of commercially pure iron to the corrosive effect of coal smoke and water caused the builders to specify this material for the cabins. Commercially pure iron will withstand rust for years. The cabins are strong, being made of 22 and 24-gage corrugated galvanized metal. About 10,000 pounds of this iron was used for roofing, and siding, ridge roll, strap iron, rivets, nails, and flashing. The dimensions of the various cabins are: two engine cabins 40 feet long by 10 feet wide by 8 feet high at eaves; one control cabin 8 feet long by 8 feet wide by 7 feet high at eaves. The size of the hull is 120 feet by 28 feet by 4 feet molded. The weight of the dredge is 315 tons gross when operating, allowing 32 tons for water and material. The net weight is about 283 tons.

New Milburn Paint Spray

The Alexander Milburn Company has developed a 3-in-1 spray gun which is adaptable to very fine work such as painting and lacquering automobiles, furniture, etc., or on coarse operations such as painting machinery, freight cars, etc. This is a triple purpose gun for use as a siphon-feed, pressure-feed, or gravity-feed spray. It is immediately adaptable to use by one of these methods, whichever may be more convenient for the work.

The construction of this gun allows it to be used on low air pressure or with an ordinary gage compressor. Consistent with the kinds of work encountered, the multiple-head adjustment permits either a flat, fan spray in either horizontal or vertical position or a round spray by a mere adjustment. The atomization is so fine and even that "orange-peel" is eliminated, minimizing sanding and rubbing. The spray can be so finely adjusted that it can be used for touching up, shading and high lighting. An air pocket, formed by the fan-shaped nozzle, completely surrounds the atomized spray and lessens the loss of material through evaporation and utilizes the entire spray in thoroughly covering the surface. When dusting is desired, a trip lever is raised, allowing the air only to function and completely shutting off the paint supply. Both the air and paint valves are operated simultaneously. By pulling the trigger, paint flows to the atomizing chamber, is expanded and driven with ample force into the pores of the surface to be covered.

Worm Gear Speed Reducers Developed by Foote

During the past few years a demand has developed for reduction units of the worm and gear type. The requirements for these units are reliability, high efficiency, compactness of design, sturdiness, quietness of operation and wear resisting qualities under severe operating conditions. To meet these requirements Foote Bros. Gear Machine Company has developed a line of worm gear speed reducers. These are made in four distinct types, the HGS with worm at bottom, HGT with worm at top, HGV vertical and HGD double reduction for high ratios. Capacities range up to 200 horse power, and a large variety of reduction ratios are provided to fit every commercial requirement.

In their design all necessary friction is eliminated in the shaft bearings by incorporating ball and roller bearings to take care of radial and thrust loads on the worm and worm gears. A special form ot tooth design is employed and the teeth are cut by the use of specially designed tools and equipment to insure accuracy in the production of worms, gears and other parts.

Precautions have been taken to insure an adequate supply of lubricant to all moving parts under all conditions of loads and speeds. The desired lubrication is secured without the oil working out along the extended shafts. Worm gears are made from chilled and cast bronze giving the desired strength and wearing qualities with the lowest coefficient of friction. Worms are made from nickel steel, carbonized, hardened and ground. This procedure insures the proper tooth contact and quietness in operation.

Climax Engineering Company Appoints Export Dealer

The Climax Engineering Company has recently completed arrangements with the Koehring Company Associates, 50 Church street, New York City, to handle the sale of Climax engines, power units, and accessories for export exclusively in the following countries: Argentina, Colombia, Italy, Panama, India, Phillipine Islands and Japanese Empire.

Due to the broad knowledge and experience of the Koehring Company Associates in the handling of products of this nature, the Climax Engineering Company believe that the interests of its foreign customers can be served to best advantage through the use of this organization.

New Incorporations

Uffington Stone Co., Uffington, W. Va. $50,000. Mike Papich, Matt Grbac, Victor Radetich, John Grbac, Matt Mirosh, Louis Marcott, Andreja Rubesa, John Dradich.

Rapid Hardening Portland Cement Co., Room 818, 134 N La Salle St., Chicago, Ill. $100,000. Manufacture and deal in cement, lime, limestone, etc. John F Cullerton, John F. Tyrell, Robert E. Murphy. (Correspondent, Tyrell, Higgins & Jamieson, 134 N. La Salle St., Chicago.)

Standard Rock Asphalt Co.. Bowling Green, Ky. $1,500,000. Own property in Edmonson County, Ky. Directors: R. W. Woodruff, Atlanta, Ga.; W. T. Elder, Long Island City, L. I., N. Y.; Edward A. McGuire, Jr., R. W. Sinclair, Kenneth S. Clark, James F. Allen, all of New York City; James E. Pederson, Duluth, Minn.; C. C. Boller, Bowling Green, Ky.

Natural Bitumen Products Corp., Ogden, Utah. $500,000. To develop asphalt deposits at Boxelder County, Ogden, Utah.

Monmouth Washed Sand & Gravel, Inc., Box 735, Freehold, N. J. $100,000. Output, 500 tons daily. George E. Fournier, Pres.; Miss Louise Vanauken, Sec'y; Patsy Sarabuchello, V.-P.; Wood A. Arrowsmith, Treas.

John J. Harris, Inc., Haddon Heights, N. J. 1,000 shares. Sand.

Volunteer Portland Cement Co., Knoxville, Tenn. $1,000,000. J. Ross Hanahan, Pres.; Howell J. Davis, V.-P.; Directors, Weston M. Fulton, C. M. Moore, Howell J. Davis.

Penglase Sand & Gravel Co., Water St., Grayville, Ill. $30,000. Own and operate pump and dredge boats for pumping sand and gravel from the Ohio and tributary rivers. George H. Penglase, George D. Negley, William L. Skiles, Francis R. Bowman, Frank E. Regall, Charles F. Speck.

Kendall Quarry & Construction Co., Fred B. Green, Jr., Kendall, Fla. $30,000.

Sinclair Marble & Stone Co., George A. Sinclair, 400 E. Davis St., St. Louis, Mo. $40,000.

Alabama Tripoli Corp., 149 Broadway, New York City. $750,000. Plan development of amorphous silica deposits at Tredegar, Ala. Charles S. McCulloch, Pres., 100 Broadway, New York City; William Zanker, Secy.-Treas., 100 Broadway, New York City; E. E. Good, Plant Mgr., Lancaster, Pa.; L. A. Henderson, Consult. Engr.

Centerville Limestone Co., Centerville, Ohio. 350 shares n.p.v., $40,000 pfd. Elmer T. Walker, Mary A. Walker, Noel L. Greenlee, Edwin W. Ellis, Howard E. Mankin.

Havlik Stone Co., 181 Woodlawn St., Aurora, Ill. $60,000, and 2,000 shares n.p.v. Manufacture and deal in building materials. Robert F. Havlik, Ida S. Havlik, James D. Benbow.

Home Rock Co., Amarillo, Tex. $10,000. H. H. Folks, F. G. Folks, C. W. Carson, Jr.

Recent Patents

1,616,844. Supporting and driving construction for gyratory grinding mills. James G. Burke, Allentown, Pa., assignor to Bradley Pulverizer Co., same place.

1,616,977. Concrete building construction. Alfred A. Koivu, New York, N. Y.

1,617,137. Rotary kiln for burning cement, magnesite, lime, and the like. Harry Stehmann, Berlin-Hohenschonhausen, Germany.

Joseph G. Worker Appointed General Sales Manager

The appointment of Joseph G. Worker as general sales manager and his election to the Board of Directors is announced by the American Engineering Company as the beginning of extensive plans for marketing its many and varied products including the Taylor stoker, Lo-Hed electric hoists, etc., and the A-E-Co line of yacht, ship and cargo-handling machinery.

Mr. Work assumes his new duties with more than 20 years' experience in engineering and sales work and an intimate knowledge of the products and policies of the American Engineering Company, acquired during the past five years as assistant to the president of that company.

New Electric Welding Manual

The Lincoln Electric Company has just issued the 1927 edition of the "Instruction Manual." This publication, which is revised annually to cover the latest practices used in manual electric arc welding, is of interest to practically everyone who uses arc welding. Among the subjects treated are: high speed steel welding, high pressure pipe welding, automobile frames, boiler repairs, welding cast iron, manganese steel welding, carbon arc welding, manufacture of machinery and equipment using welded steel in place of castings.

Indiana Limestone Company Opens New Office

The Indiana Limestone Company has opened an Atlanta, Georgia, office in the Glenn Building in charge of F. H. Sears. The new office will be headquarters of the company in this district, conprising the states of Georgia, Florida, South Carolina and Tennessee.

New Westinghouse Light and Power Plant

A new non-battery design of light and power plant is being manufactured by the Westinghouse Electric and Manufacturing Company for furnishing light and power on farms, in oil and gas fields, air mail landing fields, ships and places where central station service is not available. It is also valuable for auxiliary electric service and for standby service.

This new type of plant, type E-86, is a non-battery, 2,000 watt, 110 volt plant, particularly adaptable where the use of batteries is not desirable. The new plant will develop four kilowatt hours of power on one gallon of fuel. It is air cooled, lubricated with the splash system and no electrical parts are exposed. This plant has a shipping weight of 695 pounds.

Koehring Appoints

The Koehring Company, manufacturers of pavers, mixers, gasoline shovels, cranes and draglines, announce the appointment of Mr. K. H. Talbot as director of sales, in charge of domestic and foreign sales. For five years, from 1919 to 1924, he was associated with the company as Manager of Field Service. Mr. Talbot resigned as Manager of Cement sales of the Cowham Engineering Company of Chicago to accept this appointment.

Pioneer Rubber Mills Opens Chicago Branch

The Pioneer Rubber Mills opened a new factory branch at Chicago on February 1st. Mr. E. P. Coxhead who has been connected with this firm for ten years at its headquarters office is the manager. This firm manufactures a line of rubber belting, hose and packing. It is one of the largest manufacturers of garden hose in the world. The Chicago branch will handle the middle western states which were formerly under the jurisdiction of the New York office, thus permitting the latter office to devote its time to the Atlantic Coast states.

New Link Belt Office

The Link-Belt Company will open a new branch sales office at 229 Brown-Marx Building, Birmingham, Alabama, on March 6. W. H. Norton, for many years connected with the Chicago sales department, will assume management of the new territory, and Harold R. Haught will assist in the sales work.

NOTICE! MUST BE SOLD IMMEDIATELY

On account of our rebuilding Plant and Storage Yard at Hammond, Indiana, being under option for sale, we have to move within sixty days. Therefore, no reasonable offer will be refused for the following equipment:

CRANES

Browning 8-C Standard Gauge, 50' Boom, new July 1926, used 5 Mos.
Orton & Steinbrenner 35-Ton Std. Ga. 65' Boom, used 12 mos. completely rebuilt.
Browning 15-Ton 4-Wheel Std. Ga.
Industrial 15-Ton 4-Wheel Std. Ga. Elec. Power.
Orton & Steinbrenner 7½ ton Cat. Gas Crane 35 ft. Boom.
Marion 21 Steam Power, Cat, with Dragline Attach.
Northwest Model 104, 40 ft. Boom, with Dragline Attach.

SHOVELS

Marion Model 31 all Steel Cat. 26 ft. Boom, 17 ft. Dipper Handle, 1-yd. Dipper, used 7 mos.

HOISTING ENGINES

1—Lidgerwood 8¼x10 D/C D/D.
4—7x10 D/C D/D with Boilers.
1—Stroudsburg 7 x 10 3-Drum with Boiler.
1—Lidgerwood Swinging Engine.
1—Dobbie Holding Drum.

BUCKETS

Kiesler 1½ yd. Clam Shell.
Owen 1-yd. Clam Shell.
Hayward 1-yd. Clam Shell.
Blaw Dreadnaught ⅝ yd.
½ yd. Hayward Orange Peel.
Owen ½ yd. Digging Type.
20—30 to 35 cu. ft. Controllable bottom Dump Buckets.
Page ¾ yd. Dragline Class "S".

PUMPS

Gould Diaphragm with Fairbanks Engine.
Novo Centrifugal 8x6 Gas Power.
Morris Centrifugal 8x6 Steam.
Morris Centrifugal 4x3 Steam.
4—Aldrich Triplex 3½x4 with 15 H.P. Le Roi Engines, brand new.
2—Aldrich Triplex 3x3½ Fuller & Johnson Engines brand new.

MISCELLANEOUS

Burton 7-Ton 24 in. Ga. Locomotive.
Schramm Gas Driven Air Compressor, cap. 30 ft.
Jeffrey No. 3 Lime Pulverizer.
Gates No. 3 Gy. Crusher.
8—24 in. Ga. Turntables.
Fairbanks Morse Gas Driven Elec. Lighting Plant.
Lots of parts for Type "B" Erie Shovel and No. 4 Keystone Excavator.
Austin Backfiller.
Buckeye Wheel Type Cat. Ditcher.
Kelly 10-Ton Tandem Steam Road Roller.
3 Drop Hammers.
No. 2 Vulcan Steam Hammer.
Koehring 21-S Mixer, side loader, steam, gas or elec. drive.
Rex Mixer ½ yd. Side Loader, steam power.
Oshkosh 1-sack, side loader, gas power.
Lakewood and Insley Spouting, including Buckets and Hoppers.
Brand new complete set of A-Frame Derrick Irons with Timbers, size 12x12, suitable for mounting on Flat Car.

The above must be sold or rented to save cost of moving to our new Plant. We also have listed with us for sale over $1,000,000.00 worth of Machinery.

RENNOLDS EQUIPMENT COMPANY
702 Bell Building, Chicago, Illinois.

LOCOMOTIVES

60-ton American 6-wheel switcher, separate tender, 180-lbs. steam, built 1906.
47-ton Baldwin 6-wheel switcher, separate tender, 180-lbs. steam, ASME, Canadian boiler, built 1917.
38-ton American 4-wheel saddle-tank, built 1910.
32-ton Vulcan 4-wheel saddle-tank, Ohio boiler, 180-lbs. steam, built 1914.
60-ton three-truck Shay geared, 200-lbs. steam, built 1918.
50-ton two-truck Shay geared, 200-lbs. steam, built 1918.
57-ton two-truck Heisler, 200-lbs. steam, built 1923.

LOCOMOTIVE CRANES

22½-ton Ohio 8-wheel, two-line, locomotive crane, built 1915.
18-ton O&S 8-wheel, two-line, locomotive crane, built 1920.

CARS

17—12-yard two-way dumps, new steel center sills.
6 K.&J. 6-yd. steel under-frame, two-way dumps, standard gauge.

BIRMINGHAM RAIL & LOCOMOTIVE CO.
Birmingham, Ala.

LOCOMOTIVES

1—60-ton 6-wheel standard gauge Saddle Tank, new A.S.M.E. boiler, electric head lights, oil burning equipment.
1—14x22 cylinder, 4-wheel saddle Tank Locomotive, automatic and straight air A.S.M.E. boiler.

CATERPILLAR SHOVELS

1—68C Bucyrus electrically operated shovel on caterpillars.
1—20B Bucyrus Steam Shovel on caterpillar.

LOCOMOTIVE CRANES

1—30-ton Ohio factory rebuilt and guaranteed.
1—25-ton Ohio factory rebuilt and guaranteed.

CARS

All sizes and types.

MORRIS ENGINEERING CO.
Phone: Cortland 0604
30 Church St., New York

FOR SALE

Used Equipment for Immediate Shipment

DRYERS

7—4'x30' Ruggles-Coles and American.
1—5'x25' Allis-Chalmers.
2—8'6"x55' Mosser.

TUBE MILLS

1—3'x 8' Abbe Silex Lined.
1—4'x16' Smidth, Silex Lined.
4—5'x22' Smidth, Steel Lined.

JAW CRUSHERS

1— 6"x14" Sturtevant.
1— 7"x16½" Kite.
1—20"x 6" Farrell.
1—30"x36" Kennedy.

MISCELLANEOUS GRINDERS

2—Patterson Rolls 6"x12".
1—Buchanan Roll 36"x22".
1—24"x20" Jeffrey Hammer Mill.
1—No. 1 Sturtevant Rotary Crusher.
1—No. 1 Sturtevant Ring Roll Mill.
3—No. 2 Sturtevant Ring Roll Mills.

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We Want Your Idle Equipment for Cash
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CONSOLIDATED PRODUCTS CO., INC.
15 Park Row, New York City
BARCLAY 0603

SHOVELS

1—Bucyrus Model 103-C, caterpillar.
1—Bucyrus Model 95-C, caterpillar.
1—Bucyrus Model 70-C.
1—Bucyrus Model 50-B, caterpillar.
1—Erie, type B, steam, cat., combination crane.
1—Northwest Model 104, gas, cat.
1—Erie, type A, traction, steam.
1—No. 1 Thew, traction, steam, rebuilt.
1—No. 0 Thew, with floats, steam, traction.
1—Marine Model 2S, steam, traction, combination.
2—Keystone Excavators, Model 3 and 4.

CRUSHERS

1—No. 9 McCully, mang. fitted.
1—Farrell 24x36 in., type B, mang. fitted.
2—Symons Discs, 24 in. and 18 in.
1—Farrell 18x36 in.
1—No 7½ Kennedy, Ch. I. ftd.
2—Austin No's 7½ and 5.
1—No. 6 Kennedy, extra eccentric.
1—No. 4 Telsmith, gyratory, mang. carved concaves.
2—Universal, 3M and 2M.
1—Jeffrey Pulverizer, type B, shaker feeder.

MISCELLANEOUS

1—McMyler gas Crane, 40 ft. boom.
1—Byers ¾ yd. Crane, traction, steam.
1—Smith-Valle 14 x 12 in. Belted Air Compressor, 400 cu. ft.
1—8 in. Morris Dredging Pump, with extra mang. impeller and lining.
1—1 yd. Sauerman Excavator bucket.
1—10x10 Clyde Hoisting Engine, D. D. D. C. without boiler.
1—set of Gilbert Rotary Screens, 40 x 60 in.
1—21-E Smith gas, caterpillar Paver.
1—21-E Koehring gas caterpillar Paver.
1—21-E Rex gas, caterpillar Paver.

BOLL MACHINERY COMPANY
140 So. Dearborn St. CHICAGO, ILL.

1—25-ton Browning Locomotive Crane, 8-wheel, 50-ft. Boom
1—15-ton O & S Locomotive Crane, 8-wheel, 50-ft. Boom
1—P & H 206 Crane, 38-ft. Boom, Caterpillar Traction
1—Byers "BEAR CAT" Crane
1—Byers Truckrane
4—12-yd. Std. Gage Dump Cars
4—4-ton, 36-in. Gage Elec. Locomotives
4—12-in. Centrifugal Pumps
2—8¼x10 Hoists, Three Drum
2—7x10 Hoists, Two Drum
2—30 H.P. Single Drum Dake Hoists
1—4½x6 Swinging Engine
1—Stiff Leg Derrick, 60-ft. Boom
1—1190-ft. Ingersoll-Rand Air Compressor

J. T. WALSH
500 Brisbane Bldg. Buffalo, N. Y.

Locomotives

1—50-ton, 4 wheel, saddle tank, air brake, A.S.M.E. Boiler.
1—75-ton, 6 wheel, saddle tank, air brake, I.C.C. Certificate.

Crushers

1—Telsmith 3F Reduction Crusher.
1—Champion No. 5 11x26.
2—Allis-Chalmers & Farrell 18x30 Jaw.
2—Allis-Chalmers & Farrell 15x24 Jaw.
2—Allis-Chalmers & Farrell 18x36 Jaw.
1—Symons 24-in. Disc.

Screens

1—60-in. x 20-ft.
1—40-in. x 16-ft. with conveyors.

New Drag Scraper Bucket

1—New Hayward 1 yd. capacity, complete manganese fitted.

A. J. O'NEILL CO.
1524 Chestnut St., Philadelphia, Pa.

CRAWLER SHOVELS

1—TYPE B ERIE, Steam, New 1925, ¾-yd. High Lift.
1—MARION 32, Steam, New 1926, 1¼-yd. High Lift.
2—ERIE, GAS & AIR, New 1926. 1 yd High Lift.
3—NORTHWEST, No. 105, GASOLINE, Shovel & Crane, New 1925.
1—P & H No. 206, GASOLINE, Shovel & Crane, New 1925.

CRANES

1—12-ton cap. OSGOOD HEAVY DUTY GASOLINE CRAWLER, New Aug. 1926.
2—10-ton cap. BROWNHOIST No. 2, GASOLINE, CRAWLER, New 1926.
2—10-ton cap. BROWNHOIST No. 2, STEAM, CRAWLER, New 1923.
1—22½-ton, 8-whl. std. gauge, OHIO, Model "D," Steam Loco. Crane, new 1922, 50 ft. Boom, Bucket operating, Like new.

DUMP CARS

4-yd. to 20-yd. 36 in. and stand. gauge Dump Cars, Heavy Duty.

GREY STEEL PRODUCTS COMPANY
111 Broadway New York, N. Y.

NEW AND RECLAIMED **RAILS** FROGS, SWITCHES, SPLICES, BOLTS, SPIKES, TIE PLATES, CROSS AND SWITCH TIES, ACCESSORIES.

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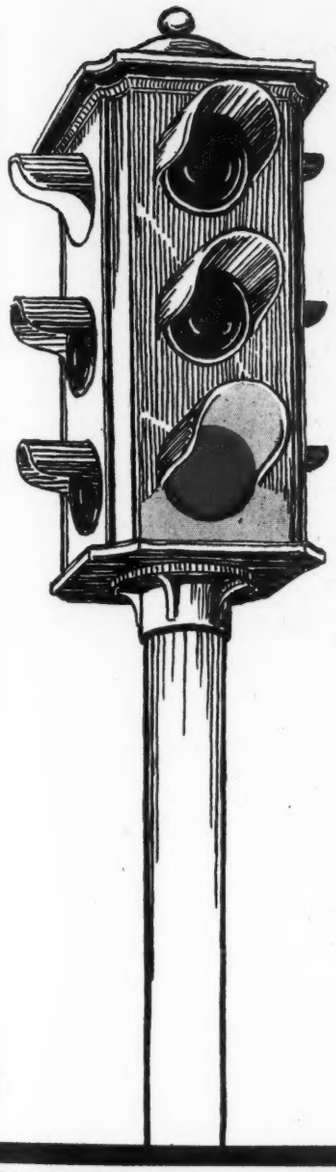
Gasoline Locomotives

2—Whitcomb Gasoline Locomotives, 7-ton, 24-in. ga. In good condition. Now in Providence of Quebec.

CARSWELL CONSTRUCTION CO., LTD.,
C. P. Building, Toronto.



STOP!

tramp iron before it stops your plant

IRON and steel will find its way into raw material—a broken drill point, a bolt or nut from the car, spikes or mule shoes from the mine.

This stray iron, if left unguarded, will wreck your crushers and stop your plant.

Safeguard your plant and your earnings.

Put a Dings Magnetic Separator on the job.

It will throw out every piece of dangerous iron.

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High Intensity
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P. & Q. 3-16—Gray

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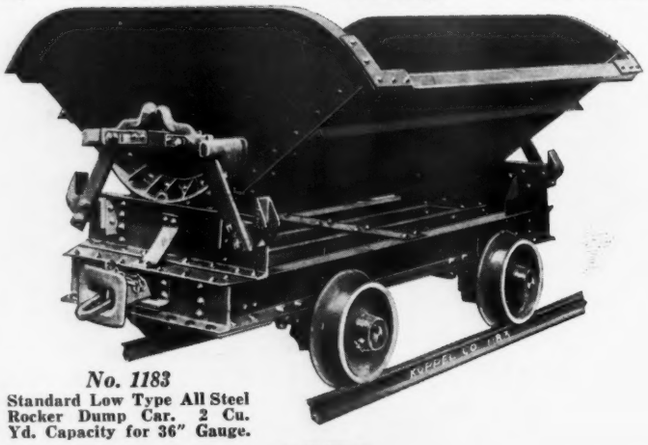

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Standard Low Type All Steel Rocker Dump Car. 2 Cu. Yd. Capacity for 36" Gauge.

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